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Speculations on a New Process

The London Branch of the Institute of British Foundrymen is to be congratulated on having secured the privilege of being the instrument for the publication of the first contribution to the study of the powder metallurgy of cast iron. The lecturer, Dr. W. D. Jones, is well known as an authority on the general question of powder metallurgy, upon which subject a very considerable literature exists. It is not generally known that Smalley has included powder metallurgy in his range of researches, but to the best of our knowledge he has confined his attentions to non-ferrous work. Dr. Jones' initial work has established a number of outstanding features. First of all there is the extremely high tensile strength reported, so high indeed that some of it could be sacrificed by an annealing treatment in order to induce a modicum of elasticity. The next feature is that apparently the phosphide eutectic acts as an agglutinant or inter-granular cement for the whole structure. The final factor is that grey-iron borings do not at the present state of our knowledge lend themselves to similar treatment because of the interference of the graphite. Probably this last statement is the most important of all, because a realisation of the reason for failure constitutes a useful signpost for success.

Mr. S. V. Williams, during the discussion, very rightly pointed out the general limitations of powder metallurgy processes, such as the difficulty of producing complicated shapes, and the magnitude of the competition from castings which would have to be overcome. Yet his contribution took one still deeper into the realms of speculation, as, for instance, the introduction of materials not easily incorporable by means of fusion, such as lead, copper, or zinc; the control of density—a factor of value when envisaging bearing metals; the possibility of different compositions and physical properties as between core and surface. It is readily admitted that so far the experiments made are only of an exploratory character and much remains to be done before the region of usefulness or even of application can be clearly defined. The ranges of composition, temperature, pressure and time will have to be co-ordinated before a true picture of the potentialities can be fully established. Once these factors are decided, a correlation with the cost of the raw material—at present the finest sievings from the chilled-iron shot manufacturing process—and their availability in quantity, will set the limit to the commercial possibilities of the new process. The only other source of white iron in disintegrated form in any quantity that we can think of is that from the roll-turning shops, but in this case the composition is different. The cost of grinding and sieving this material by the manufacturers of chilled-iron grit might provide a still cheaper raw material and may in addition yield as a by-product a grade useful for shot blasting. At the very least, by mixing with the higher phosphorus chilled shot fines, some information as to the influence of this element on the tensile strength of the sintered pressings would be forthcoming, and Dr. Jones' theory based on its action as a cement confirmed or rebutted. In our opinion, the one is just as likely as the other, as the weldability of fine particles of metals is in no way related to that of heavier masses of the same composition, and so far as wrought iron is concerned a high phosphorus is definitely disadvantageous.

Obviously, the real prize in any consideration of the powder metallurgy of cast iron is the utilisation of grey iron turnings, on account of their cheapness and quantity available. If, as Dr. Jones points out, the graphite content is the noxious element, its dissolution without fusion and quenching presents an interesting problem. Experiments in the direction of mixing with alkaline earth salts before heating and pressing might yield interesting results, but we fear the retention of too much slag, rendering the compact only useful for remelting. Even this should be worth while, as a means of the cheap reclamation of what is often a drug on the market. The presentation of such a novel Paper as the one under discussion acts as a welcome mental stimulus for metallurgists and may well prove to be the genesis of a new field of commercial enterprise, of which the foundry industry has every chance of being the originators.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Use of Manganese Ore in the Cupola

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The article on the use of manganese ore in the cupola, in your issue of November 17, by Mr. B. Ramaseshiah, B.E., of the Mysore Iron and Steel Works, is of great interest, not only for what is stated but for what is omitted, as pointed out in your no less interesting leader on the subject.

I recently made some experiments in the use of iron ore in the cupola. Our blood is often made to run cold by authoritative statements as to the results of the presence of iron oxide in the cupola, so the experiments were made to see what would happen with quite a lot of it present; and also with visions of the production of iron from the cupola having the famous cold-blast qualities. Further, some experiences have led me to conclude that iron deteriorates on remelting, even when composition is adjusted, and that a melting saved is to the good.

The experiments covered three runs only, in a 36-in. dia. Poumay cupola, normally melting 6 tons per hour. On each occasion the ore was used in connection with the production of a low-silicon iron, made up in six 10-cwt. charges (to give 3 tons in the ladle) followed by softer charges. Usually the charge is of the order: 4 cwts. Scottish hematite, 2 cwts. low-phosphorus iron, 2 cwts. home scrap and 2 cwts. steel plates, with 90 lbs. coke and 25 lbs. limestone. The ore used was a brown hematite from Ouenza, said to contain 52 to 53 per cent. Fe and 1.5 per cent. MnO. In the first test, 1 cwt. of ore was placed on top of the third metal charge, whilst the coke charge was increased by 28 lbs. and the limestone by 15 lbs. The steel proportion of the charge was reduced to 1½ cwts.

On the second occasion, two charges of ore were used in a similar way, placed on the third and fourth charges. On the third occasion three 1-cwt. charges of ore were placed on the third, fourth and fifth charges respectively. The ore had been broken to pieces of 2 in. to 4 in. The effects on composition are shown below:—

Test.	Average Si in charge.	Si in casting.	Average Mn in charge	Mn in casting.	G.C	C.C	P	S
1	1.23	1.08	1.21	0.78				
2	1.23	1.05	1.23	0.75				
3	1.30	1.06	1.26	0.41	2.72	0.62	0.18	0.116

The silicon and manganese losses in the first two cases were normal. In the third the silicon loss was slightly high for this cupola, whilst the manganese loss was very high. The metal in the castings shows nothing unusual in the fracture, though they (44 cwts. each) have yet to be machined and steam-tested. No strength tests were made of the metal.

An important matter is the effects of ore in the cupola. Its presence distinctly lowers the melting rate. Six charges of this character are normally brought down into the ladle in 30 minutes, but, with 3 cwts. of ore present, 45 minutes were required. The ore seemed to blanket the cupola, with the result that, until the ore was reduced and melted, the blast pressure stood at 16 ozs. instead of the normal 14 ozs. What happened in Mr. Ramaseshiah's cupola, where he introduced the use of coke breeze in order to reduce the manganese ore, it would be interesting to know, for the blanketing effect must have been more pronounced.

On the first of the tests described here, the cupola wall suffered only normal erosion. On the second, a little more than normal erosion had taken place, but on the third occasion when 3 cwts. of ore were present, the lining in the region of the melting zone was badly eroded, requiring 5 cwts. of ganister over the usual quantity to make good, as well as extra time for repairing.

I will not trouble you with a balance-sheet of the operations, but I conclude that, if the whole of the iron in the ore came down into the ladle, losses and gains are about even. I also conclude that, on the whole, reduction of ore had better be left to the blast furnacemen. Mr. Ramaseshiah's figures undoubtedly show some gain from the use of manganese ore, but I fear the whole story has not been told. At the same time, he is to be congratulated for undertaking the experiments, which I hope he will have the courage to continue, and give us later the benefit of his conclusions.—Yours, etc.,

J. LONGDEN
(Foundry Manager, D. & J. Tullis, Limited).

Clydebank, Glasgow.
November 23, 1938.

French Foundry Industry

To correct the error relating to French pig-iron production figures given in last week's report under the above title, the following amended figures are given: The output of pig-iron in France in January to September last was 4,475,000 metric tons, the monthly figure declining from 643,000 tons in January to 419,000 tons in August, and advancing again, to 446,000 tons, in September. The number of blast furnaces in operation, which was 101 in January, was around 78 during the September quarter. The production of phosphoric foundry iron was 454,000 tons in the nine months, having declined from 60,000 tons in January to 46,000 tons in September, and of hematite foundry iron 167,000 tons, which also declined, from 28,000 tons in January to 15,000 tons in September, after touching 16,000 tons in August. Definitive figures for October have not yet been received, but are believed to be about the same as in September.

(Continued from next column.)

Another of London's whimsical conductors, regularly engaged on the No. 13 route from St. John's Wood to the West End, since the influx of Viennese refugees has taken to calling out, "Alight here for Bakerstrasse!"

* * *

A little girl and her mother were waiting for a bus on the Chiswick High Road. Mother couldn't remember what number bus she had been told to take.

"I know, mummy," volunteered the little girl, "It's the 'Jesus loves me' bus."

That, however interesting as an example of mnemonics (good word, that!) wasn't much use to mother, as neither she nor her daughter could recollect the number of that hymn in their hymn-book.

The railways are asking for a square deal, so they say. Nevertheless, they want to get round the transport laws.

"MARKSMAN."

"Fofumi" Rotary Furnace

King, Taudevin & Gregson, Limited, Melbourne Chambers, Cambridge Street, Sheffield, have issued an illustrated handbook dealing with the "Fofumi" rotary-hearth furnace, whose chief characteristics are the shape and design of the burner, atomisation of the fuel, quality of the refractory lining, simplicity of teeming and slagging operations, and facilities for sampling and correction. The handbook deals with the design, charging, sampling, controlled heating, and construction, lining, rotation, burner, and recuperator of the furnace, together with practical data of steel melting.

Random Shots

Everyone is familiar with the fellow who has a passion for statistics. Sometimes he is an intolerable bore, but he has been at it again, and this time has produced some entertaining figures pertaining to the activities of the average man of fifty years of age. To begin with, the average man has spent time equal to about 6,000 days in sleeping alone. He has devoted something like 1,500 days to eating (numbers of roly-polies and steak and kidney puds. not specified). Illness has claimed about 500 days (at the time it always seems more than this); 4,000 solid days has he spent on sports and pleasures, whilst working has claimed a paltry 5,500 days. The frequent complaint of those who say that life is "all work and bed" is thus definitely disposed of, for even excluding all the etceteras he spends rather more of his life in slumber than at work!

* * *

This plausible statistician cannot be living in London, for he would have felt himself bound to include in his division the time spent underground in London's tubes, and that time can neither be counted as a sport nor a pleasure! One regular traveller up to town from his suburban dormitory declares that he spends at least three weeks every year underground, and he is quick to add that he doesn't frequent night clubs either!

* * *

There is ample evidence this week that not every hard worker complains that life is all work and bed, for have not Petter's, of Yeovil, entered a spirited team in the Cup Ties of the Football Association? In the first round played last Saturday they had the good fortune to win and thus foundrymen will be able to watch their further progress with interest.

* * *

Whilst some take to football as a sport, others take to politics, and for considerations this week this must be counted either as a sport or perhaps a pleasure, for, as will be shown, political activity does not always oust business interests. How much time spent in the House itself is devoted to slumber it would be quite impolitic to ask! Among foundrymen, as it happens, political activity seems to be unusually popular. Why an early training in foundry work should produce a flare for politics it is difficult to say, unless the casting of votes has anything to do with it! It is a fact, however, that many persons prominent in the political world are also in some way connected with foundries. Only to mention a few, was not the late Mr. Arthur Henderson originally a moulder, risen to leadership through the hard school of the National Union of Foundryworkers? Mr. Chamberlain himself in his early days was a student under Prof. Turner at the Birmingham University. The present member for the Midlothian Division of Glasgow is the Rt. Hon. D. J. Colville, a director of the well-known Scottish steel firm. The numbers include also Sir Frederick Mills, Member for East Leyton, who was the first man to use a moulding machine for making ingot moulds; Mr. Stokes, who is the Member for Ipswich and chairman of Ransomes; Mr. W. F. Higgs, a Member for Birmingham, who has a prosperous foundry making motors; and the very President himself of the Institute of British Foundrymen, Mr. J. Hepworth, is the Member for East Bradford.

* * *

A strapping head of a welfare department in one of London's East End works was going home by bus. As the bus turned the tricky corner at which she wished to get off, she hesitated for a moment on the stairs.

"Come on, Miss," roared the conductor, "'Urry up, now! Legs is no novelty to me!"

(Continued in previous column.)

The Powder Metallurgy of Iron with Particular Reference to "Pacteron"*

By W. D. JONES, M.Eng., Ph.D.

Early Work

It is proposed to discuss in this Paper the capabilities and possibilities of powder metallurgy in the ferrous field. The subject is not a new one; at least it can be said definitely that the technique was used 110 years ago in the working up of platinum because we have an account of the matter in a Bakerian lecture by Wollaston in 1829.[1] This method is still in use to-day and consists briefly in taking a fine platinum powder, pressing it in a die until it forms a compact sufficiently strong to be handled and

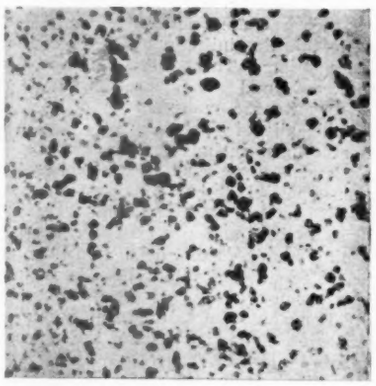


FIG. 1.—UNETCHED. × 400.

then heating it to a high temperature. At no time is the temperature sufficiently high to melt the platinum, but nevertheless a welding or sintering together of the powder particles takes place which brings about an increase in density from something like 5.0 after pressing to 17 or 18 after heating. Forging at high temperature finally causes a consolidation to the approximate theoretical density of 21.4.

The powder technique is followed in the case of platinum principally because of the high melting-point of the metal, which makes casting inconvenient. Of course, platinum is a particularly suitable metal for this technical approach, it is easily obtained in powder form by chemical methods, and it welds or sinters very readily because it does not oxidise at high temperatures.

It was natural that the powder technique should be followed in the case of other high melting-point metals, and this has been so with tungsten, which is universally worked up from sintered powder compacts. Tungsten, however, oxidises very readily at high temperatures and therefore must be sintered in a protective atmosphere.

New Applications

Some years ago it was realised that the powder technique not only permits the more convenient handling of high melting-point metals but has attractive possibilities in enabling one to produce metal articles which are almost impossible of attainment by casting methods. The principle example is the porous bronze or oil-containing bearing. This is made by pressing together a mixture of copper and tin powders in a die and the compact formed is afterwards sintered in a protective atmosphere. The circumstances in this case are somewhat different from those of a monometallic compact, since during a portion of the sintering time a partial melting occurs, in this case the tin, and the finished compact comprises a porous conglomeration of copper particles surrounded by most of the phases which are permitted by the copper-tin diagram. The porosity can be closely controlled by adjustment of the analysis, pressures and temperatures.

These three fields, platinum, tungsten, and porous bronze (together with other not less important offshoots—the hard metal cutting alloys, the G.E.C. "Heavy alloy") comprise the principal applications of powder metallurgy and the simple methods employed comprise the basic technique.

Application to Iron

The manipulation of iron has followed along similar lines. The I.G. Farbenindustrie drew close attention to iron by producing finely-divided iron powder by the carbonyl process. This powder can be extremely fine and pure and of varying carbon and oxygen contents, and is very suitable for sintering. Protective atmospheres are necessary, of course, in the case of iron alloys manipulated by the methods already mentioned, and the correct choice of atmosphere so that carburisation, decarburisation, oxidation or deoxidation are under control provides some very pretty problems. An interesting discovery in connection with this powder is that the powder mass can to a considerable extent provide its own protective atmosphere by the interaction of its carbon and oxygen contents, although in this case it is impossible to press the powder into a compact before sintering because the mass must be maintained very porous in order to allow the gases formed to escape. Working along these lines Duftschmid, Schlecht and Schubardt[2] have prepared very pure masses of iron with varying carbon contents which, after consolidating by forging, have shown the following mechanical properties:—Tensile strength, 12.7 to 17.8 tons per sq. in.; elongation, 30 to

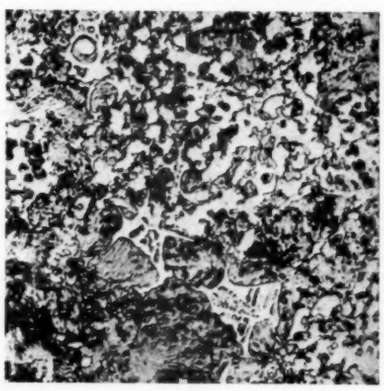


FIG. 2.—ETCHED 2 PER CENT. NITRIC ACID IN ALCOHOL. × 400.

40 per cent.; reduction of area, 70 to 80 per cent., and Brinell No. 56 to 80, and with deep-drawing properties as measured by the Erichsen test apparently superior to copper.

The most important investigation of this type has, however, been undertaken by Offermann, Buchholtz and Schulz[3], and was reported in full in German and in English in "Stahl und Eisen." In this case the investigators worked with 2-ton masses of carbonyl iron powders sintered at various temperatures without the application of pressures. A set of steels was produced which were remarkably similar in physical properties to cast steels of corresponding compositions. Difficulties were experienced in obtaining uniformity of carbon distribution, and some peculiarities of these steels, for example, the tendency to develop coarse carbide areas[4], were attributed more to their unusual purity than to their method of manufacture. Deliberate addition of impurities, notably phosphorus, sulphur and manganese, rendered these steels much more normal.

Work such as this is, of course, extremely interesting from an academic point of view, but from a practical standpoint there would not appear to be any substantial reason for steel

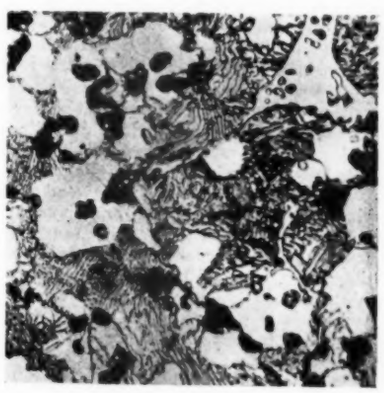


FIG. 3.—ETCHED, AS FIG. 2. × 1,200.

manufacture along these lines unless it is to attain alloys which are impossible by casting methods or unless the technique is justified on the grounds of cheapness. Unfortunately, however, carbonyl iron powder considered as an iron commodity pure and simple is expensive.

Commercial Applications

The possibilities of obtaining porous masses in iron has, of course, received attention, and the methods employed were probably guided by the porous bronze-bearing practice. One interesting application is for moulds for metal casting[5]. Carbonyl iron powder sintered into the form of porous blocks can readily be cut to shapes and sizes which are suitable for the manufacture of moulds; the material can be arranged to have a wide range of thermal conductivity and by the local application of pressure before or during sintering it is possible to arrange for non-porous areas to act as chills. The material has, of course, the necessary porosity for the transmission of gases and is superior to sand moulds in strength. Similarly porous iron masses have been suggested or have found application in accumulator plates, filter bodies for gases and liquids, lamp wicks, safety devices on gas burners, catalysts, and of course the porous iron bearing has and is still receiving considerable attention.

The Case of Cast Iron

One cannot deny that there must be a big future for the methods of powder metallurgy in the ferrous field, but there is one matter, and one matter only, which has to a large extent held everything back, and that is the high cost of the iron powder. Some three years ago

* A Paper read before the joint meeting of the London and Sheffield Branches of the Institute of British Foundrymen.

[1] W. H. Wollaston, Phil. Trans. Roy. Soc., 1829, 119, pp. 1-8.

[2] F. Duftschmid, L. Schlecht and W. Schubardt, "Stahl u. Eisen." 1932, 52, pp. 845-849.

[3] E. K. Offermann, H. Buchholtz and E. H. Schulz, "Stahl u. Eisen," 1936, 56, pp. 1132-1138. E. K. Offermann, "Über die Herstellung und die Eigenschaften von Stahl aus Carbonyleisen," Dortmund, 1936.

[4] F. Duftschmid and Ed. Houdement, "Stahl u. Eisen," 1931, 51, pp. 1613-1616.

[5] B.P. 330,018.

the author's colleague, Mr. E. J. Groom, deliberately looked around for a cheap iron powder and without looking far came to consider cast-iron grit used for shot blasting, and which is popularly known as steel grit. Considered as a powder it is a cheap commodity, the price of which is well known. A considerable amount of work on sintering this material has led to the general elucidation of its properties and to the development of a selected grade of grit especially manufactured and suited for the purpose which is handled by the firm of Powder Metallurgy, Limited, under the name of "Pacteron," and is patented in the United Kingdom or by applications for foreign protection.

The author is privileged to give here a very brief account of the physical properties of sintered "Pacteron" iron powder. The grade of powder upon which the following work was conducted contained:—Total carbon, 3.16; silicon, 1.13; manganese, 0.58; sulphur, 0.126, and phosphorus, 1.154 per cent. which is in no way unusual for this class of material. The sieve analysis is controlled to give a more or less uniform distribution of particle sizes from 80 mesh down to minus 400 mesh.

For the purposes of this investigation, the powder was pressed into a rectangular alloy steel die under 8 tons per sq. in. and heating was conducted by inserting the pressing contained in its die in a muffle furnace already at the sintering temperature. No precautions against oxidation were observed, the pressings were in fact subjected to atmospheric oxidation throughout the entire heating period. Immediately on attaining the sintering temperature the die was removed from the furnace and the compact repressed under 8 tons per sq. in. The compact was allowed to cool in the die before ejection and then machined to test-pieces and specimens for micro-examination and density measurement.

The commencement of consolidation is approximately 400 deg. C. Pressings made at this temperature are sufficiently strong to be handled. A gradual increase in strength is obtained with rising temperatures until at 800 deg. C. a tensile of 2 to 3 tons per sq. in. is obtainable. No significant changes are observable up to 880 deg. C. The compacts obtained over these temperatures are porous (the density being approximately 6.25) and weak (2 to 3 tons per sq. in.), and the Brinell hardness is approximately 130. From 880 to 975 deg. C. there is a uniform improvement in mechanical properties and a continuous change in microstructure, involving the appearance of nodules of temper carbon and the disappearance of cementite which is the main constituent of the original powder, and the general formation of pearlite. Some oxide is also visible under the microscope, where it will be noticed that the grain size is fine, and the temper carbon nodules in particular are small compared with those customarily found in malleable castings.

Fig. 1 at a magnification of 400 diameters shows the microstructure unetched and Fig. 2 the microstructure etched with 2 per cent. nitric acid in alcohol of a compact pressed at 975 deg. C. This structure is more clearly seen in Fig. 3 at a magnification of 1,200 diameters. The white areas are ferrite, the half tone, phosphide eutectic, and the nodules of temper carbon and pearlite areas are plainly observable. Pressed at this temperature the compacts have the remarkable tensile strength of 35 to 36 tons per sq. in., densities of 7.0 to 7.1, and Brinell hardness 260 to 270. The variation in these physical properties with pressing temperature is shown in Fig. 4. At temperatures higher than 975 deg. C. there is little change, if anything there is a tendency towards deterioration until the melting point is reached. At the higher temperatures there is a general reduction in pearlite until, at 1,100 deg. C., the microstructure shows only ferrite and nodules of carbon with some phosphide eutectic.

It is difficult to explain the unusually high tensile strength from a material of this analysis, particularly when it is remembered that cooling was slow and that considerable oxidation had occurred. The bonding of the powder particles is undoubtedly effected by the melting of the phosphide eutectic at 950 to 960 deg. C. and under the influence of pressure this liquid is presumably able to break the oxide films, allowing consolidation to take place.

This principle of compaction by the combined use of pressure and the presence of a small percentage of a liquid phase is an important one, inasmuch as oxidation during sintering becomes apparently relatively unimportant. In connection with iron, the author has extended the principle by making use of alloy additions to iron powders which melt at lower temperatures than 975 deg. C., and it has been possible to obtain good physical properties at these lower temperatures. It should be pointed out that these pressings in Pacteron exhibit no appreciable ductility, but this is a property of the analysis, and is not apparently caused by oxidation, although there are indications that by controlling the extent of oxidation it is possible to

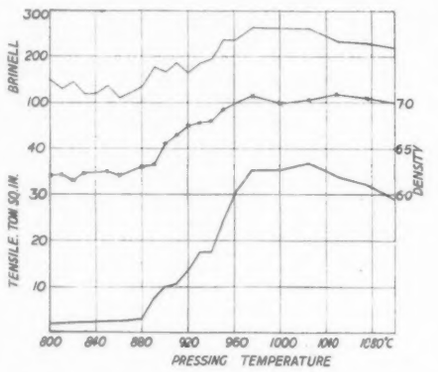


FIG. 4.—INFLUENCE OF PRESSING TEMPERATURE ON PHYSICAL PROPERTIES.

modify the physical properties, in particular the manner in which the material fractures.

The Future

These remarks concerning the sintering of Pacteron are to be regarded as introductory. There remains much more to be discussed and considerably more work to be done. It is necessary to make clear, however, that it is not suggested that the commercial applications should be manipulated by the technique which has just been described and which is essentially a laboratory technique. Possibly the best method of approach will be by means of electrical sintering, that is, by using the powder as an electrical resistance and passing a heavy welding current through it whilst pressing. There are indications that comparatively low pressures of 1 to 2 tons per sq. in. may be sufficient under such circumstances. Moreover, there remains the possibility of compaction at low temperatures, that is, 400 to 500 deg. C., followed by something in the nature of a drop-forging treatment. This matter will be investigated further.

Doubtlessly, those interested in this work will be led to consider if this powder technique holds out any possibilities in connection with their own specific interests and problems. When considering the possible applications of Pacteron, one should remember that here is a comparatively cheap material of very ordinary analysis capable of giving tensiles of the order of 35 tons per sq. in., that the product is undoubtedly susceptible to modification by heat-treatment or alloying, which presents fascinating possibilities, and that in effect there is here the means of making something similar to a die-casting, but at considerably lower temperatures than is possible with iron die-casting. Moreover, there are combined with this all the peculiar possibilities of the powder metallurgy approach; that is to say, it is quite feasible to produce compacts containing non-alloyable constituents, or incompletely alloyed constituents or even non-metallic constituents, and these can be included in a microscopic or macroscopic scale. The method permits unusual facilities in controlling particle sizes and shapes, or in obtaining localised volumes of special physical or mechanical properties, and in controlling oxide content. The peculiar advantages of the powder approach are, of course, very numerous indeed, and by no means sufficiently well known as they should be.

New Materials Available

Some time ago the author had occasion to remark that progress in powder metallurgy was considerably hampered by the almost complete absence of alloy powders. Whilst it was possible to obtain most metals in powder form, nevertheless it was practically completely impossible to purchase at any price even the most well-known alloys, such as manganese steel, stainless steel, Monel metal, aluminium alloys, etc., in the form of fine powders. This state of affairs has now been altered, and a new process has appeared which permits the manufacture of almost any conceivable alloy in the form of a fine powder. The method also includes mixtures of immiscible metals, and even metals and non-metals, so that it becomes possible to have fine powders of copper and lead, iron and lead, and even such fantastic mixtures as iron and glass, with *every* particle containing hundreds of nuclei of all the constituents. The state of sub-division is so fine that no segregation occurs when the powders are sintered. For want of a better term, it is proposed to call these peculiar varieties of the new powders "emulsified powders."

The possible applications of such materials are simply immense, and discussion of some of them must be left for another occasion. At the moment it suffices to state that such powders are available to those who wish to experiment with them, and it is suggested that everyone should reflect upon what could be done with a powder, not necessarily in connection with sintering, if there were practically no limitation of choice of constitution. Almost any metal, alloy, or emulsified mixture of immiscible metals or metals and non-metals is available for sintering, pigments, abrasives, pyrotechnic purposes, spraying, and so on.

Publication Received

A Hundred Years of Progress. By THOMAS L. PRICE. Published by F. Bailey & Son, Limited, Dursley, Glos. Price 1s.

This 44-page booklet gives a historical record of the firm of Blackstone & Company, Limited, of Stamford, Lincs, from its birth in 1837 to the present time. The firm was started by Henry Smith, a member of the same family which to-day operates Smith & Grice, of Thrapston. In 1853, Mr. T. W. Ashby joined the business, which became known as Smith & Ashby, and later T. W. Ashby & Company. The name was again changed in 1868, when Mr. G. E. Jeffrey became a partner, and the firm was known as Ashby & Jeffrey. After Mr. Ashby and a third partner, Mr. Lake, retired, Mr. Blackstone became Jeffrey's partner. This was in 1877, and it was only in 1889 that the concern became known under its present title of Blackstone & Company, Limited. The author, not unlike the racing man who establishes dates by reference to Derby winners, has correlated the firm's engineering developments with the Royal Shows. This is no doubt due to the fact that Mr. Price—whose death we reported only a few weeks ago—was a regular attender of the Shows on behalf of his firm.

What We Do Not Know About Cast Iron

DISCUSSION IN LONDON

Mr. J. E. Hurst's address on the subject of "What We Do Not Know About Cast Iron," published in our last issue, was of outstanding interest to the members of the London Branch of the Institute of British Foundrymen. The discussion upon it brought into relief the difference between engineering and metallurgical appreciation and utilisation of research results.

The discussion was opened by the BRANCH-PRESIDENT (Mr. C. C. Booth, J.P.), who commented that the very interesting and instructive address given by Mr. Hurst, who himself had been responsible for such a great deal of research work on cast iron, served to emphasise the necessity for the Institute to find solutions of the problems raised.

Inherent Difficulties

DR. A. B. EVEREST (Past Branch-President) said he had been very gratified to notice that some of the most important engineering institutions to-day were beginning to realise that there was a lot we did not know about cast iron, thereby recognising the development of high-duty irons. It was interesting to contrast that attitude with the one which seemed to have been adopted in the past by engineers, that cast iron was cast iron and that we knew all about it. As evidence of that change of attitude, he mentioned that the Institution of Mechanical Engineers had set up a committee to study high-duty cast iron, and that that committee would shortly present a report and the whole question would be aired before the Institution.

The difficulties experienced in connection with cast iron were in evidence at a recent meeting of a committee (outside the Institute), of which he was a member. The discussion had developed on the critical percentage of phosphorus and the relation between phosphorus and unsoundness, which had been the subject of argument for the last 50 years. It was significant to hear so many views on such a basic problem, but the committee hoped that, by the selection of data, it would eventually reach a conclusion on this long-standing question.

The trouble with cast iron was that its production involved consideration of from 10 to 15 variables, and the more variables there were, the more difficult it became to understand it properly, to put diagrams on paper and to approach fundamentals. It was rather alarming that, with the passage of time, the number of variables tended to increase rather than decrease, and with each new variable there was introduced a whole succession of properties and structures about which we knew nothing. It had been pointed out by Mr. Hurst that in connection with cast iron we must consider the fundamental factor of the relation between carbide and the graphite, but that most of what we did not know about cast iron depended on the influence of four other elements of its properties. If one analysed a modern cast iron, however, one found that there were often eight or ten elements present, some perhaps picked up from scrap. Then all the melting and moulding conditions introduced fresh variables. It was not surprising, therefore, that the final product in many cases presented properties and features we did not understand.

A 63-ton Cast Iron

One of the directions in which research was being directed in connection with high-duty cast iron to-day was that of the study of the irons which mostly cast white and were then given some sort of heat-treatment. He had seen a test figure of 63 tons per sq. in. recently, relating to a cast iron prepared by that method, and it seemed to him—and it was a matter upon which he asked for Mr. Hurst's opinion—that the study of the breakdown of the combined carbon to a graphitic carbon under controlled conditions was one of the most profitable lines of future development.

Finally, Dr. Everest said that it seemed as though Mr. Hurst, in dealing with the subject, had gone only halfway, and he suggested that Mr. Hurst might be invited to present a further Paper entitled "Cast Iron Ten Years Hence."

Two Decades of Progress

MR. A. LOGAN recalled that he was first introduced to the problems of cast iron in 1918, and when he compared cast iron as it was then, with the alloy known as cast iron to-day, he had a very lively appreciation of the progress which had been made in that period. It might well be said that what we did not know about cast iron in 1918 would have filled several books. In the meantime, Mr. Hurst had written the equivalent of several of those books, and our knowledge had improved a good deal as the result of his investigations. Mr. Logan said that he had an intense appreciation of the amount of work which Mr. Hurst personally had conducted in clearing up many points which had been obscure, and of his dissemination of the results of his work. Mr. Hurst was very modest about it himself, and had not said a word in his Paper about the work he had done to provide the answers to many questions.

The difficulty, as had been pointed out, was that cast iron was referred to as though it were quite a simple alloy, whereas it would be difficult to find anything more complex in the whole realm of metallurgy. Even the very simplest cast irons, so called, were not simple at all; the investigation of any one particular composition might entail weeks of work, and it was the tremendous amount of complication when additions were present in an alloy which rendered the study of the more complex cast irons so very difficult. The metallurgist was frequently coming up against quite a number of fundamental properties of which he knew very little; in many cases he had to guess the answer or arrive by empirical methods at an answer which seemed to fit, but he was still left wondering as to the fundamental causes of the properties existing.

The metallurgist wanted to know more about the viscosity of fluid iron, and how the effects of temperature and gas content varied with composition. There was also the question of the oxide content—the possibilities were endless. In connection with the preparation of piston rings and similar small articles, one was frequently perplexed by matters such as internal stresses and volume changes and the manner in which they were affected by composition and casting conditions. We knew very little about the factors controlling the En value, which had an important bearing on piston ring manufacture. Plastic deformation was another quality which could vary quite a lot, and we were very much in the dark concerning its control.

Wear Resistance

A problem which Mr. Hurst had not referred to, to any great extent, and one with regard to which reams could be written, was that of the wear of cast iron. Although we had been studying wear and the factors controlling it in cast iron for twenty years, we still knew very little about it. Impact brittleness was another factor about which we should like to know more. If we could determine completely the factors which controlled graphitisation we should have travelled a long way forward in understanding cast iron.

Finally, Mr. Logan said that he had been rather intrigued by the reference in the Paper to "bendable" cast iron, and he asked why it was required, because he would have thought that one of the fundamental properties required in iron castings was rigidity.

Cylinder Liners

MR. R. B. TEMPLETON, in commenting upon a reference by Mr. Hurst, said that on a gap cut in a test ring taken from a large 20-in. diameter liner he found there was a closing of the gap after heat-treatment. He said it was their practice to heat-treat these liners to 300 Brinell. The specification allowed plus or minus 6 thousandths of an inch on the gap cut in a 20 in. liner, and they never found an opening, but always a closing of the gap by 3 to 4 thousandths after heat-treatment. He had never tested the gap immediately after quenching, *i.e.*, when the ring was fully hardened, but these results were obtained after the final tempering stage. He asked whether, in the case referred to by Mr. Hurst, there was any difference in the gap of a test ring in the "as-cast" condition compared with the gap of a test ring in a heat-treated condition.

MR. HURST said he was not speaking of a change in the internal diameter of the ring, but of a change in the gap cut in the ring.

The Work of the Foundry Metallurgist

MR. N. BURNS, speaking as an engineer rather than as a metallurgist, said it seemed to him that when one had decided what one did not know, one should ask why one did not know it. Foundry metallurgists were concerned with an art or a science involving a remarkable quantity of variables, and if they experienced trouble, they might alter any one of those variables and arrive at the result desired. But when next they experienced that trouble, they could never be sure that they could cure it in the same way, and his own experience and contact with foundrymen suggested that hardly any of them were able to ascertain why they could not cure it in the same way.

Commenting on a reference by Mr. Hurst to a friend who used dry blast, Mr. Burns asked how many foundrymen to-day could say accurately how much air they had put into the cupola after allowing for barometric conditions and humidity, or how much coke they had put into the cupola; and if they knew all those quantities, how many of them could reproduce the same cupola operating conditions daily, by which he meant the rate of melting, the period of holding in the well and in the fore-hearth?

In view of the large variety of irons made, he suggested that ironfounders should follow the practice that was followed in the steel industry, *i.e.*, concentrate on one group at a time and tackle all the problems in that group, altering one variable at a time. They should first deal with the production of the molten metal, then the mould, facing sands, core sands, etc., ultimately arriving at the factors affecting the soundness of castings. It was important to tackle the various problems in their proper order; so many people were apt to start in the middle and to deal in different ways with the same castings, so that during recurrent trouble they did not know where they were.

With regard to physical tests, he said ironfounders seemed to him to fail badly in respect of their knowledge of the variations in the modulus of elasticity of irons of similar analysis. From what he had seen of foundries in this country and abroad, it seemed that research to-day into the physical properties of cast iron was very limited and that we were only just entering on the phase upon which the steelmakers had entered probably 50 years ago.

Cupola Blasts

MR. A. SQUIRE, bearing in mind Mr. Hurst's reference to the drying of air admitted to the cupola, asked whether founders had attempted to go a step further and to condition the air. In different parts of the country and at different times of the year, the atmospheric conditions varied, there being impurities in the air at various times. If large quantities of air were admitted to the cupola without treatment, large quantities of impurities were being admitted also, whereas if the air were washed and dried, passed through a refrigeration plant, and then admitted to the cupola at a definite temperature, most of the impurities would be excluded.

MR. J. KING, discussing the magnetic permeability of cast iron—a matter which had been dealt with only briefly in the reports of scientific associations—asked which element had the greatest effect on that property in cast iron.

AUTHOR'S REPLY

MR. HURST, in expressing his thanks for the appreciative remarks which had been made concerning his Paper, said he had been very much concerned as to whether he had been able to deal with his subject in an interesting manner; certainly he would not like to adopt Dr. Everest's suggestion to present a further Paper under the title "Cast Iron Ten Years Hence." Indeed, he would toss the ball back and suggest that Dr. Everest himself was well qualified to deal with such a subject.

He appreciated Dr. Everest's reference to the importance of the heat-treatment of white irons with the object of producing something in the nature of malleable irons. The test result mentioned, of 63 tons per sq. in., in connection with some form of heat-treated white iron was extraordinary, and was very intriguing. He personally had not seen figures at all like that in such irons, but in some work which was probably of a similar character he had obtained equally stupendous figures in respect of alloyed materials containing nickel and molybdenum, and he felt sure that there was a tremendous field open to the industry in that direction.

In reply to Mr. Logan, he said he had not dealt in the Paper with the problem of the wear of cast iron, but obviously in that connection there was a wide variety of matters on which we still required knowledge. At the same time, it was true to say that substantial improvement had been effected in the course of years in the production of cast-iron materials suitable for use in wear-resisting conditions. He ventured to think that some of the early cast irons produced 20 or 25 years ago, such as Mr. Logan had in mind, would give very poor service, as compared with the service of some of the materials available to-day, under the conditions imposed in some of the present-day engines.

Bendable Cast Irons

Dealing with Mr. Logan's question as to why a bendable cast iron should be produced, he said it all depended upon one's own particular interests. Some time ago he had heard a friend express the view that he would be prepared to sacrifice 10 tons in tensile strength if only he could get 5 per cent. elongation in his cast iron; and presumably many engineers would be glad to have such an iron. That was the meaning of the reference in the Paper to the need for bendable cast iron. Of course, if such a cast iron were produced, it did not follow that the bendability was obtained at the sacrifice of rigidity, as defined by the modulus of elasticity.

Dealing with Mr. Templeton's question concerning the gap due to internal stress in a test ring cut from a liner, he said that, so far as he was concerned, in centrifugal castings the opening tended to be positive, *i.e.*, the gap tended to open outwards, as distinct from negative or closing inwards. Of course, the manner in which the test ring was cut had a bearing on that. If one cut small rings approximating to some proportion of the radial thickness, and tried to explore the gap opening across the radial thickness of the liner, one would find differences as one proceeded from the outside surface to the inside; those differences in centrifugal castings tended to be positive the nearer one approached to the outside surface, and negative at the extreme inside surface. In the case of sand castings, he believed that they would tend to be positive at the outside surface, tending to the negative in the centre and then tending to the positive again at the inside surface. But the average result on any sizeable proportion of the radial wall thickness in a centrifugal casting in the as-cast condition was usually positive. That additional explanation was due to Mr. Templeton, because one might come across it particularly if turning a ring from a thick flange where one might get only a small percentage of the cast radial thickness in the ring.

The Engineers' Way Out

In thanking Mr. Burns for his comments, he said he was not quite sure whether the intention was to be critical of the metallurgists. Of course, metallurgists were an unfortunate class of people and could not handle their problems in quite the same way as the engineers could handle theirs. He pointed out jocularly that engineers were able to get out of their difficulties and complexities by the use of what they called "coefficients." They devised a beautiful formula based on very nice mathematical reasoning; but when they had worked it out beautifully to a nice answer, and found that it did not just coincide with practical experience, they invented what they called a "coefficient," which was stuck into the formula to help them out of their difficulties (laughter). Unfortunately, the metallurgists could not do that, which was perhaps their misfortune; nevertheless, they did try to tackle their science in quite as systematic a way as did the engineers.

Having said that, Mr. Hurst said he felt that Mr. Burns' criticism with regard to the delay in applying research to cast iron, as compared with the application of research to steel, was justified; it was true that not nearly so much work had been done in regard to cast iron from the points of view mentioned by Mr. Burns as had been done in the case of steel. Probably that was a legacy from the old days, when cast iron was used more or less for bridge building and purposes of that kind. The only property that mattered then was the ultimate breaking strength in transverse bending. The method of assessing cast iron on that basis had stuck through the years, even though the use of cast iron for such purposes had been abandoned for years. It was only the realisation by engineers that cast iron possessed properties peculiar to itself, which properties could be obtained only in cast iron, and their use of it for its own sake, that was responsible for the modern interest in the application of research to cast iron.

Influence of New Conditions

He welcomed the suggestion made by Mr. Burns to group cast irons for the purposes of investigation. Probably the commercial development of cast irons, and particularly the newer alloy cast irons, would be still more rapid than at present when we were able to group them and classify them, as alloy steels had been classified; the various nickel steels, nickel-chrome steels, molybdenum steels, manganese-molybdenum steels, and so on, were capable of being grouped into classes which were clearly understood by the engineer, who, knowing the conditions he had to meet in the design of his structures, knew which group of materials to use. An engineer never bought a nickel steel if a plain carbon steel would suit his purpose, and before he placed an order he knew what type or class of steel he required. Once the alloy cast irons could be classified on those lines, so that the engineer would know at once whether the conditions he had to meet merited the use of a special alloy cast iron in a particular group, then the cast iron industry would make still further progress. At the same time, we should not be blind to the fact that the cast-iron industry had made substantial progress during the last ten years.

Replying to Mr. Squire, he said that he did not know of any case in which the air admitted to cupolas was conditioned.

He was doubtful also that he could answer satisfactorily Mr. King's question concerning magnetic permeability. The combined carbon content particularly was of considerable importance, as was also the silicon content, and, of course, work had been done on the effect of phosphorus; he was not sure that the influence of some of the other elements had not been studied also. However, a fairly systematic study of the magnetic properties of cast iron had been made in the early days of the British Cast Iron Research Association, and from the results one could obtain specific information as to magnetic permeability.

Vote of Thanks

MR. CROMPTON LAKE, proposing a vote of thanks to Mr. Hurst, said that there was no need to attempt to indicate Mr. Hurst's accomplishments in the field of cast iron at any meeting of foundrymen; his activities in that field were well evidenced by information published in THE FOUNDRY TRADE JOURNAL, and by the number of awards that had been made to Mr. Hurst from time to time for his services. By his Paper he had proved that "the more we know we know, the more we know we do not know."

MR. BROWN, seconding, said that the type of Paper presented by Mr. Hurst was particularly valuable, because metallurgists did not realise how much they did not know about cast iron. Their realisation in regard to many things would come in later years, as they learnt of the properties that would be required; they had very little appreciation at the moment that they ought to know of those properties, simply because they were not demanded. The Paper by Mr. Hurst had awakened interest very much in some of the weaker links in the chain of evidence in the development of cast iron, and a great debt of gratitude was due to him for leading them to think further about the subject, because the deeper they delved into it the more they would appreciate how very little they knew.

The vote of thanks was carried with acclamation.

MR. HURST, responding, said he appreciated very much the opportunity of addressing the London Branch and of meeting many of his friends in London and from other parts of the country. Speaking on the theme that the older we became the less we claimed to know about the particular subjects in which we were interested, he recalled that in 1916 he had lectured in Manchester on the subject of cylinder wear, and at that time he had thought that he had known all there was to be known about the subject. To-day, however, 23 years later, he was quite certain that his knowledge at that time must have been very vague.

MR. BURNS said he hoped that the criticisms he made with regard to metallurgists and cast iron were constructive and not destructive. He wanted to emphasise that if the investigation of the subject was started on the ground floor we should realise more fully the things we did not know, and would set out to investigate progressively.

MR. HURST said he quite appreciated that Mr. Burns' criticism was constructive; his own remarks concerning engineers, of course, were quite jocular.

IMPERIAL CHEMICAL INDUSTRIES, LIMITED, has disposed of its holding of shares in the Imperial Smelting Corporation, Limited. It is reported that the buyers are the British Metal Corporation, Limited, and the Central Mining and Investment Corporation, Limited.

Early Development of Ironfounding in England

By RHYS JENKINS, M.I.Mech.E.

(*Concluded from page* 391.)

Moulding the Guns

Of the manner in which the moulds for the iron guns were prepared, no description has come down to us. For the bronze guns we have information, more or less definite, at various dates, and, such as it is, one need not hesitate to accept it as applying substantially to the production of iron guns, particularly as it has been mentioned that a founder of bronze guns, Peter Baude, was sent from London to Sussex in 1543 to make the mould for the founding of the first iron gun.

In 1517-18 King Henry VIII had a bronze gun cast for him at Fontarabia, on the north coast of Spain. The master founder was a Genoese, Jacobo de Lerrucci de Palma. The King's agent was Thomas Batcok, merchant of Bristol, then a resident in Spain, and what is known of this affair comes from his accounts of expenditure. It seems that this was the second attempt to cast the gun, for mention is made of a culverin "that was fayled of his castyng." Women were paid for "digging the ground where the culverin was cast," and bread and wine were given "to the people that hauled the piece of metal . . . to the house of fondition and wound it up to put it in the oven," also "to those that helped to wind up the culverin out of the earth after it was cast, and take off the bands and earth." Payments were made to men who helped to "cleanse" the gun, take out the heart [core] and bore it. Steel was bought, and a smith paid for making and mending the bores, likewise "for the making of the ire [iron] that should hold the hart [core]." Wax was bought "to make the King's arms and other conceits" in the mould and "bran that was cast in when the metal was molt and ready to be cast." In addition to the old gun, 18 cwts. of copper was used, and when the new gun was brought to England 60 lbs. of borings came with it. The gun weighed just over 51 cwts. and was named the Poundgarnet of Fountraby.[18] The gunstones weighed 14 lbs. each.

Robert Norton, "one of his Majesties Gunners and Engineers," in his book "The Gunner," published in 1628, has a chapter under the title "Of Making of Moulds for the Founding of Ordnance." The description is not so clear as one would wish for, but it does indicate a method differing from what is thought to have been the usual method of loam moulding for guns, and is deserving of notice, although Norton concerns himself only with bronze guns. First, it is to be understood that the mould is in two main parts, that for the chase, and that for the breech end. "A modell or perfect patterne" of chase is made of "timber or of earth (or both)." This is anointed with soft hog's grease and has applied upon it a coating of "tempered earth, made and dried little by little, augmenting it untill it be of a competent strength and thickness." The column thus formed "must be taken into two or more parts to the end to take the said modell or patterne out of it." This description suggests the use of a permanent pattern, not one that has to be destroyed to remove it from the mould, and it would seem that the mould was made in two or more lengths. Norton goes on to say that the mould "is to be fortified on the out-side with Plates of iron as long as the Chase of the Peece and with iron wyres an inch each from other, and lastly with iron hoopes a foote or two asunder, to knocke off and on as occasion shall require." The core is to be "made of the same earth, moulded upon a strong Iron square Barre and upon a cord woulded upon the same"; it is to be centred in the mould "by helpe of the Base and Muzzle ring." "All these must be well joynted together, polished smooth and dryed and nealed." "Lastly the patterne of the Breech . . . . is in like manner to be covered over by little and little with the same tempered earth," and the mould so made "luted neatly and strongly" to the other mould.

The mouldings, arms and other devices may be applied to the pattern either in wax, earth or plaster. This author draws particular attention to the necessity for vents, "every mould (that is to be filled with Brasse or any other Mettall) must have spyralls or vents: for there is no place (although called empty) so voyd, but it is filled with Ayre."

This is one of the five things he considers are to be specially regarded in the casting of metal. Another is "to have the moulds well nealed with charcoales or dry wood."

The earliest account of any real value is that given by Sirurey de Saint Remy in his "Memoires d'Artillerie" published at Paris in 1693. The following description is based upon it:—

The moulds for the breech end, the chase and the head are formed separately. The first thing is to make the false pattern for the chase. A tapered core bar A of wood (Fig 1), with a gudgeon at each end, is placed on a pair of stands B, B, so that it may be turned by handbars C secured on the big end beyond the gudgeon. The bar, having been well greased, is wound with a straw rope secured at its ends by nails (Fig. 2). Upon the rope are applied one after the other (Fig. 3) coatings of loam (*terre grasse*) mixed with powdered brick. For the last coating butter and horse-dung are mixed with the loam; this coating is finished by the aid of a loam board D (Fig. 1) with a metal edge, which forms the collars, etc. The false pattern is dried after each application by a fire built beneath it. The ornaments, etc., are next applied; they are made of wax in plaster moulds. The trunnion patterns are of wood and they are held in place on the wooden bar by two long nails.

To form the cope or mould the false pattern is coated with grease, then a layer, comprised of fine loam, horse-dung, butter and clay, is laid on and dried without fire. This is followed by other layers of loam mixed with horse-dung. When the mould has attained a thickness of four inches and has been dried by fire, the nails that hold the trunnion patterns are drawn, the patterns pulled out and the openings closed with loam.

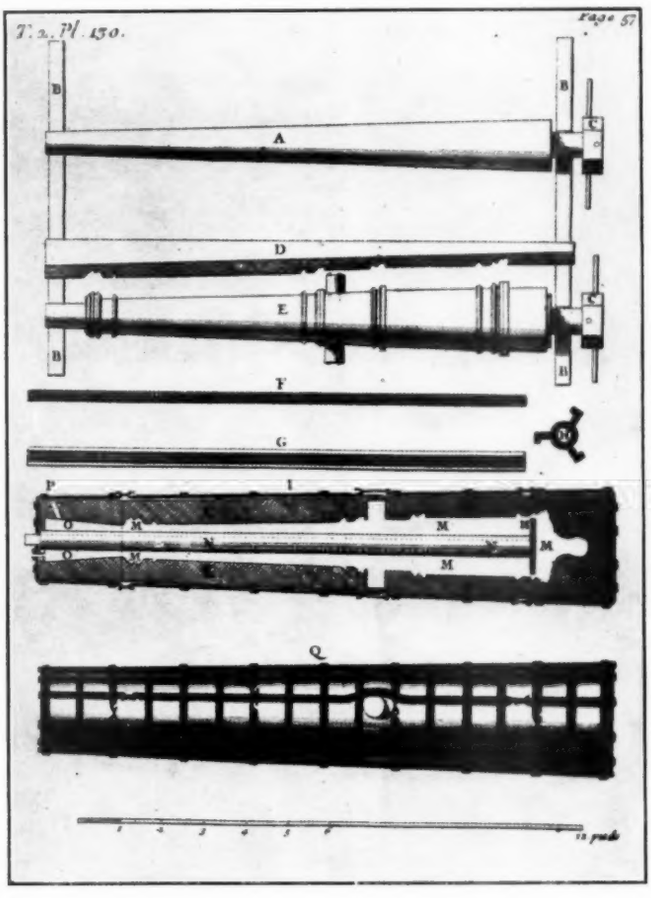


FIG. 1.—TACKLE USED IN MOULDING OF CAST-IRON GUNS.

The mould is then bound around and longitudinally with iron bands (Fig. 4), and another coating of loam is applied. The mould for big guns is usually five to six inches thick.

Removal of the False Pattern

First the nails securing the straw rope are drawn, the small end of the wooden core bar is then tapped with a hammer to loosen it so that it may be drawn out by the other end, and the rope is pulled out. The mould is now set upright in the casting pit and burning wood placed inside; the heat melts the grease that lies between the pattern and the mould, and it dries the loam of the pattern, so that it may be readily broken

[18] "Letters and Papers of Henry VIII." Appendix. Vol. I. Part I. No. 220.

up with an iron tool, leaving the interior of the mould clear.

The core is described as an iron bar F, G (Fig. 1), coated with a paste of ash (*cendre*), well dried and enclosed in wire longitudinally and spirally. [The description given of the construction of the core is not at all satisfactory.] It is inserted in the mould and held at the closed end by a chaplet (*chapelet*) H.

FIG. 2.—APPLYING STRAW ROPE TO CORE BAR.

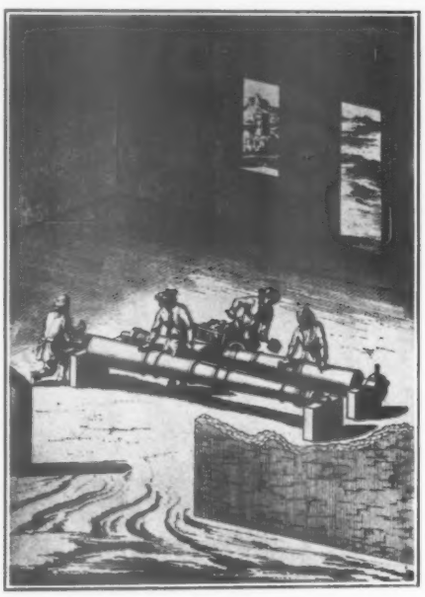


FIG. 3.—APPLYING LOAM TO THE FALSE PATTERN.

The moulds L for the breech end and O for the head are brought up to the mould for the chase, and the three parts are bound together by iron bars disposed longitudinally and circumferentially I, Q (Fig. 1). The complete mould is then placed in the pit for casting. Fig. 5 shows the breaking up of the moulds.

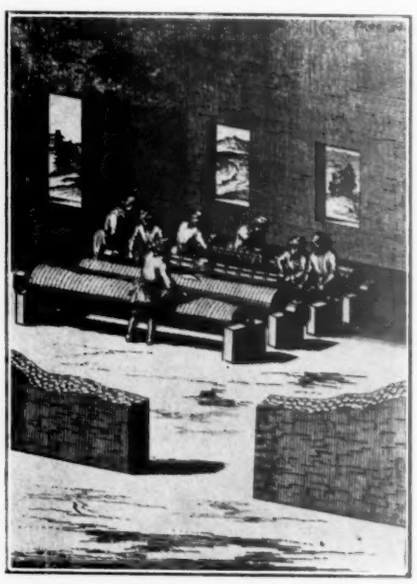


FIG. 4.—BINDING THE MOULD WITH IRON BANDS.

FIG. 5.—BREAKING UP MOULDS.

Straker in "Wealden Iron" has given us an account based on Monge's "L'Art de Fabriquer les Canons," published a century later, which is substantially the same as that given above.

The procedure followed by the Sussex gunfounders in the eighteenth century seems to have been much the same as those described by St. Remy. The accounts of the Fullers, ironmasters at Heathfield for the years 1703-54,[16] show considerable purchases of loam—202 loads in 1738, 100 loads in 1744 and 80 loads in 1745; sand was bought also, but not to a large amount. A good deal of iron wire was used and in two sizes, the larger on the inside and the smaller on the outside of the mould. The consumption of tallow or butter amounted to rather more than 2½ lbs. per ton of guns cast, that of hair was from 1½ to 2 bushels per ton. Other items mentioned are iron for chaplets, wood for drying the moulds, and devils to burn it in. There are a number of entries for gun boards, *i.e.*, loam boards for guns of different sizes, but it is to be noted that in 1704 the carpenter was paid "for making pattern and mending and putting in of gudgeons" as well as "for a bord to make ye 24 pounders on." This suggests that for some of the guns, perhaps the smallest sizes, permanent patterns were used.

[16] "Gunfounding at Heathfield." Herbert Blackman. Sussex Archl. Colls. Vol. 67.

Notes from the Branches

South African Branch.—The October meeting was devoted to a discussion on "Technical Education for the Foundry Industry," Mr. A. H. Guy presiding. A memorandum was presented by Mr. J. G. Findlay which covered both the training of trade lads and the syllabus for a National Technical Certificate. He suggested that a three-years' course should be organised in such a way that the first year should be devoted to chemistry and mathematics, and either theory underlying moulding, or theory underlying patternmaking or engineering metallurgy; the second year to iron and steel manufacture (grade I); geology and mineralogy (grade I) and foundry metallurgy. The final year, he proposed should cover iron and steel manufacture (grade II), metallography, and industrial administration. There was the usual division of opinion as to whether evening classes are preferable to day-time study; prize incentives, and so forth.

Wales and Monmouth.—Members of the Wales and Monmouth Branch of the Institute of British Foundrymen paid an official visit to the Cardiff Engineering Exhibition at Greyfriars Hall, Cardiff, last Saturday. They were welcomed by Mr. E. Ivor David, President of the South Wales Institute of Engineers, under whose auspices the Exhibition was held.

The thanks of the visitors for the invitation were expressed by MR. R. G. WILLIAMS (President of the Wales and Monmouth Branch) and MR. J. J. MCCLELLAND.

Company Meeting

Dunswart Iron & Steel Works, Limited

The annual meeting of the Dunswart Iron & Steel Works, Limited, was held in Johannesburg on November 15. MR. J. K. EATON (chairman) said that the balance sheet revealed a satisfactory position. The expansion of the company's works and the rearrangement of the plant foreshadowed last year had been proceeded with. The extensions to the steel plant, the foundry and buildings were all virtually completed. Two of the steel furnaces had been linked up with the new transformer, and the change-over in respect of the third furnace would be completed shortly. The company now possessed an extremely well-equipped steel foundry. Last year he referred to the pronounced shortage of supplies of steel scrap in South Africa, with the result that there had been a considerable increase in the price. During the year, owing to this shortage, it became necessary to purchase quantities of pig-iron to supplement their raw material. This had the obvious result of increasing the cost of production. It was very gratifying, however, to be able to record that the utilisation of pig-iron met with considerable success from a technical point of view. The pronounced shortage of steel scrap had been alleviated during recent months, and it had been possible to build up substantial scrap reserves. The cost of production should be substantially reduced during the present year in comparison with the year under review, but this would be somewhat offset by the fact that the competition from overseas manufacturers had resulted in the South African iron and steel producers reducing the price of rolled steel sections.

Czecho-Slovak Iron and Steel Output

The output of pig-iron in Czecho-Slovakia in October is provisionally estimated at 59,135 metric tons and steel output at 84,174 tons, as compared with 104,000 and 160,000 tons respectively in September last. It is estimated that the recent dismemberment of the State has resulted in the loss of about 35 per cent. of the capacity of the iron and steel industry, the greater reduction in the October figures as against those for September being ascribed to political events and difficulties in delivery. In addition, the armaments industry was idle during October. The iron and steel industry is now occupied in working off orders which had been put back by the need for concentrating on armaments' production.

Training of the Metallurgist

OBSERVATIONS ON WORKS- AND UNIVERSITY-TRAINED MEN, AND THE VITAL IMPORTANCE OF CHARACTER

At a meeting of the Midland Metallurgical Societies, held in Birmingham, there was a discussion on the "Training of the Metallurgist," which was initiated by MR. W. F. BRAZENER, whose remarks we append.

MR. W. F. BRAZENER said it should be remembered that metallurgists were developed mainly in two different ways. In one group were those who, after achieving something in the nature of a matriculation standard at school, had started in works laboratories. Thereafter, they combined their daily routine tasks with evening study at technical colleges, in order to attain their status as metallurgists. The other group consisted of those who took a university course and entered industry not entirely as novices, but presumably armed with the necessary groundwork to enable them, after some relatively short experience in works routine, to undertake with intelligence any of the usual tasks that fell to the lot of the metallurgist in a works.

Continuing, the speaker said he would consider these groups in turn. It was customary to take a youth just leaving school and to place him on some routine task in the works laboratory. Here, the greatest stumbling block to the budding metallurgist was the monotony of laboratory routine. In a relatively small works this may not be quite such a handicap during the first year or two as it was in the laboratory of a larger works. In the latter, it may be necessary for the determination of some constituent in an alloy to be taking place constantly throughout the day. Whilst the beginner was mastering the detail of this routine analysis, there was generally an interest exhibited in the work, but once proficiency had been attained and the individual found himself becoming little more than a mere machine, there was an obvious tendency for boredom to set in. For that reason it should be the object of those in charge to lessen the monotony by alternating the laboratory tasks amongst the staff to the greatest possible extent. Furthermore, if the best chances of the youth's development were to be attained, he should not be tied up entirely in the laboratory. If he had a chance of assimilating works routine, he would be encouraged to take greater interest in the rather confined atmosphere of the laboratory. Thus, as the years passed, the trainee would be gaining his practical and theoretical knowledge simultaneously. Starting with routine analysis, he should, amongst other things, be brought into contact with metallography, physical testing, heat-treatment, pyrometry and foundry work. He would also become acquainted with fuels and refractories, in addition to having acquired a good general knowledge of the works routine. The extent of that knowledge would, of course, depend upon the size of the works and the variety of materials which were fabricated there. Perhaps the greatest handicap to the metallurgist trained in that manner was that, although he may become relatively expert in dealing with such materials as were handled by his own particular works, his knowledge of those metals and alloys outside his daily routine would be almost negligible.

Academically-Trained Men

Referring to the university-trained man, the speaker pointed out that conditions would of necessity be rather different. Upon taking up a position in a works, the new graduate must, at least for a time, be prepared to consider himself a novice who was starting a new course of instruction. Then the employer must, for some time, realise that a man straight from the university must have time in which to assimilate works routine and practices, and he must not expect immediate results. If, after a time, the graduate could not combine his works experience with his previous training to show some benefit, or at least to maintain an established proficiency, his company would have made a bad investment. Mr. Brazener felt, however, that given the correct works training and a certain amount of patience, the percentage of misfits would not be of undue proportions.

The question would probably be asked as to which type of training produced the most efficient metallurgist. The real answer to that question was that ultimate success depended more on individual qualities than on the type of training received. Given, however, an equal measure of common sense, capacity for work, and thoroughness in the mastery of detail, it was his opinion that the university graduate should achieve the best result. If he did not, then he considered he would have wasted some of his opportunities.

Having by one or other of the methods mentioned, attained sufficient knowledge and technique to claim the title of metallurgist, and having been given a position of some responsibility in the works, the real training of the metallurgist would begin.

Best Training Ground

One of the most profitable training grounds for the metallurgist was in the investigation of complaints. The fundamental characteristics of metals and alloys became deeply embedded in the mind by these investigations, also the best methods of production could often be evolved by arriving at the real cause of complaint. That brought up the fact that not infrequently the metallurgist was the ambassador of his company to its clients. Not only in the case of answering for the sins of faulty metals did that occur, but also in giving advice as to the most suitable metal or alloy to use for any particular job. Although perhaps of only minor importance to the metallurgist as such, it was of considerable advantage to be a good "mixer," and that purely human side was not achieved without training.

Two Principal Factors

There were, to Mr. Brazener's mind, two principal factors for the successful training of the metallurgist. The first lay in the determination of the individual himself to take his job seriously; the second, to which he placed great importance, was the attitude of the employer. Although he had little criticism of the methods now in common use for the academic training of the metallurgist, he felt that those responsible should do more to advertise their wares to the leaders of industry. If employers fully realised the number of positions of importance which trained metallurgists could fill with distinction, more attention would be paid to facilities for works training. Further, he would urge any metallurgist not to consider his training complete until he had made himself an authority on at least one metal or alloy, or some phase of metallurgical knowledge. There was always a chance that such knowledge may on some occasion carry with it a great advantage.

For those who aspired to become works metallurgists, a last word was offered for their special consideration. A works metallurgist may be of the active or passive type. The latter was content to confine himself more or less to a laboratory, and issue reports concerning this or that, as a result of his investigations. The active type went farther. He followed his report into the works, and by personal supervision ensured that its precepts were being put into effect. Being on the spot, he was able, by virtue of his training, to give the immediate advice and instruction which might make all the difference between failure and success. It was not sufficient that he be content with broad outlines, but he must pay attention to the minutest details, and see that those were carried out.

Integrity

MR. A. L. MOLINEUX asked what one expected in the way of service from the metallurgist. Chiefly that he should be absolutely honest so that one could believe everything he said. Metals were becoming more complicated, and if the metallurgist told them a metal had been normalised at a certain temperature one had to believe him. He must also be *persona grata* with men and management alike. He would suggest that the metallurgist should have impressed upon him that absolute integrity was essential.

Plaster Patterns

BY H. R. THOMAS.

Although plaster of paris is used extensively in some patternshops, in others it is rarely seen. This may be owing to the nature of the work produced not lending itself to the use of this material. There are jobs, however, which, when produced as a wood pattern, are rather costly in patternmakers' time and timber and could be more easily made in plaster. Such an example is that of a pattern for a cast-iron trimming punch for use in conjunction with a drop-forging plant, a typical case being illustrated in Figs. 1 and 2. Fig. 1 shows a crank and Fig. 2 the trimming punch required which suits the periphery of the drop forging. The author knows of shops where a full wood pattern would be

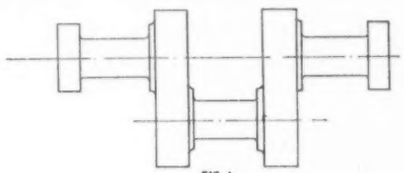


FIG. 1

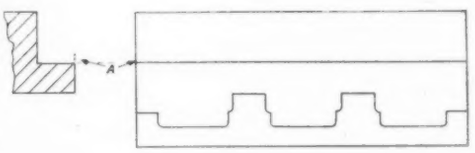


FIG. 2

carved to make this job, but it has been found that plaster is an ideal way of making these patterns—which, incidentally, are usually only one-off jobs. When a trimming punch is required, it is customary for the forge to send along with the drawing of the punch a lead cast from the top half of the die, and this can be utilised to produce the pattern. The method is to place the lead cast on a suitable board and then build around it a rough frame to the outside shape required and to the height of the tongue portion A as detailed in Fig. 2. The lead and wood frame being coated with oil, plaster of paris is run in and reinforced where necessary with pieces of wood, nails, etc., and allowed to stiffen. After a few hours a pattern, which is the exact profile of the forging, is ready. The top part A is usually made in wood and dowelled on to the lower portion.

Time Saving

Providing the plaster is correctly mixed, this method allows of a trimming punch to be rushed through the pattern shop and foundry in a much shorter time than would be required if a wood pattern was carved out of the solid. The more complicated the profile the greater the saving. This example is one instance of the economic use of plaster patterns.

An Investigation into the Use of Metallic Abrasives*

By J. E. HURST and W. TODD

The importance of the cleaning operation in general, and the quality of the metallic abrasive used in particular, in the preparation of castings is referred to very frequently in all discussions on the subject of vitreous enamelling. For this reason the authors were of the opinion that an investigation into the behaviour of the metallic abrasive during the cleaning operations could be expected to provide information which might be of use both to the enameller and also to the manufacturer of metallic abrasives. Apparently there is little or no published information of an exact character on this subject. In view of this, the authors decided to collaborate in an experimental programme, with the particular object of exploring the behaviour of metallic abrasives under ordinary service conditions in the cleaning of iron castings for vitreous enamelling purposes. The nature of the disintegration; the effect, if any, of the service conditions on the sharp-edged granular character of the grains, and the possibility of the circulating stream of abrasive in the blasting machine becoming contaminated with dirt, graphite and other non-metallic bodies were the aspects of the behaviour of the metallic abrasives in which the authors were particularly interested. During the investigations certain other items relating to the service value of abrasives were collected, and these will be referred to individually in the description of the experimental work.

Experimental Procedure

The whole of the experiments were carried out in a room-type shot-blast machine equipped with a suction arrangement for lifting shot to the feed chamber through a cyclone dust separator, the dust being exhausted into the main dust-exhaust mains in the blasting department. The size of the room was approximately 6 ft. by 6 ft. by 8 ft., and all the experiments were conducted with 60 lbs. per sq. in. air pressure using $\frac{5}{16}$-in. nozzles.

The castings to be cleaned were taken from the ordinary production of one of the authors' works, and the total weight of castings cleaned during each experiment was recorded. In experiment No. 1 the shot-blast room was thoroughly cleaned out and a weighed quantity of 5 cwts. of new shot introduced into the machine. It was decided to use this quantity of shot, without the introduction of any new shot, until it became exhausted, taking samples every hour from the circulating shot stream. The shot before use and the hourly samples were submitted to magnetic separation to determine the percentage of non-metallic matter present. After magnetic separation the samples were submitted to a sieving test for the determination of the grade analysis. The shot samples also were examined microscopically with the object of ascertaining the effect of service conditions on the granular shape and sharpness of the edges.

* Paper presented at the Annual Conference of the Institute of Vitreous Enamellers in London.

It will be appreciated that in the operation of a machine of this kind the dust grades are continuously separated from the circulating grit stream, thus diminishing the quantity of grit in circulation. In the absence of any additions of new grit to the machine a point is reached finally where the amount of grit in circulation is insufficient to enable cleaning to be carried on effectively. This point was reached in experiment (1) after 39 hrs.' blasting, when the experiment was stopped and the machine cleaned out to obtain the weight of shot remaining in the machine. The results of the grade analyses of the original grit and the hourly samples are assembled in Table I. This table includes also the total weight of the hourly samples and the percentage by weight of the non-magnetic material in each sample. Incidentally, the grade of grit used was No. 16 angular, and the additional information concerning experiment (1) is given below:—

Experiment No. 1.

	Tons.	Cwt.	Qrs.	Lbs.
Total weight of:				
No. 16 angular grit added to machine	—	5	0	0
„ „ „ remaining in machine	—	2	1	6
„ „ „ used	—	2	2	22
Castings cleaned	4	6	2	3
„ rejected after cleaning	—	7	3	4
Nett weight of castings passed after cleaning	3	18	2	27
Weight of grit used per—				
Gross ton of castings cleaned	—	—	—71.5	
Nett ton of castings cleaned	—	—	—78.25	

An examination of the grade analyses in Table I shows very little change in the grade analyses for the greater part of the duration of the test. Very early in the test there is a slight increase in the 40 fraction and a small amount of 50 fraction appears in the circulating load. Towards the end of the test, after about 30 hours, the coarser fraction 16 undergoes definite diminution with a consequent increase in the lower fractions. The percentage of non-magnetic

TABLE I.—*Experiment No. 1. Grade and Magnetic Analyses of Consecutive Hourly Samples of No. 16 Angular Grit.*

	Wt. of sample Grams	Percentage remaining on sieve number.												Percentage non-magnetic material.
		14.	16.	18.	24.	30.	40.	50.	60.	100.	150.	200.	—200.	
Original No. 16 grit	200	0.6	40	14	40	4	1.4	—	—	—	—	—	—	0.013
1 hr.	136	2	44	11	36	6	1	—	—	—	—	—	—	0.003
2 „	255	1.3	41	11	36	6	2.6	1.3	0.4	0.4	—	—	—	0.0015
3 „	203	1	38	13	36	8	3	1	—	—	—	—	—	0.0032
4 „	194	3	42	12	32	7	3.5	0.5	—	—	—	—	—	0.0015
5 „	183	—	39	12	40	7	1.4	0.6	—	—	—	—	—	Tr.
6 „	222	2.5	43	11	32	5.5	3	2	1	—	—	—	—	0.003
7 „	181	—	36	10	36	8	6	3	1	—	—	—	—	0.022
8 „	158	—	2	10	39	10	6	3	2	2	—	—	—	0.031
9 „	185	—	33	10	39	8	6	3	0.5	0.5	—	—	—	0.020
10 „	289	1	35	9	35	9	6.5	2.8	0.7	0.7	0.3	—	—	0.017
11 „	295	0.7	31	75	33.5	8	4.3	2	2	0.7	0.3	—	—	0.061
12 „	266	—	30	10.2	40.0	10	5	2.8	0.4	0.4	0.4	0.4	0.4	0.010
13 „	260	—	40.8	9	28.0	7	4	3.5	0.2	3	1.2	0.3	1.2	0.115
14 „	228	—	17.0	7	36	13	12	6	2.5	3.5	1	1	1	0.23
15 „	238	—	33.0	12	37.6	9	5	3	0.4	—	—	—	—	0.003
16 „	197	—	39	12	39.0	8	2	—	—	—	—	—	—	Tr.
17 „	310	—	33	11	39.0	9	5	2	1	—	—	—	—	0.007
18 „	292	—	36	11	39.0	9	4	1	—	—	—	—	—	0.0008
19 „	300	—	30	10	40	12	6	1	1	—	—	—	—	0.0008
20 „	315	—	26	10	46	13	4	1	—	—	—	—	—	Tr.
21 „	257	—	41	12	41	5	1	—	—	—	—	—	—	Tr.
22 „	225	—	36	11	40	8	3	2	—	—	—	—	—	0.004
23 „	285	—	19	9	50	15	6.3	0.7	—	—	—	—	—	Tr.
24 „	202	—	39	9	40.5	8	3.	0.5	—	—	—	—	—	0.006
25 „	167	—	21	7	43.5	14	9	4	1.5	—	—	—	—	0.024
26 „	300	—	33	9	36	10	8	4	—	—	—	—	—	0.032
27 „	323	—	19	7	42	20	10	2	—	—	—	—	—	Tr.
28 „	257	—	38	10	40	8	4	1	—	—	—	—	—	0.009
29 „	225	—	26	12	40	12	6.0	3	1	—	—	—	—	0.009
30 „	283	—	33	9.5	42	9.5	5	1	—	—	—	—	—	Tr.
31 „	178	—	25	10	45	11.5	5.5	2.5	0.5	—	—	—	—	0.004
32 „	210	—	26	8	42	13	7	3.5	0.5	—	—	—	—	0.033
33 „	208	—	19.4	9.6	44.5	15	6.8	1.4	0.5	1.4	1.4	—	—	0.030
34 „	229	—	25.9	11.5	45.6	12.2	3.9	0.9	—	—	—	—	—	0.0015
35 „	214	—	19.4	9.3	40	14.9	5	0.9	0.5	—	—	—	—	0.0045
36 „	320	—	10.6	6.7	48	20	12.5	2.2	—	—	—	—	—	0.003
37 „	197	—	21.3	10.2	47.5	13.2	6.1	1.5	—	—	—	—	—	0.001
38 „	293	—	15.0	8.9	48.5	17.6	7.5	2.5	—	—	—	—	—	0.003
39 „	270	—	15.2	7.4	39.0	20.2	13.0	2.6	2.6	—	—	—	—	0.120

material in the circulating stream is very small indeed. The group of samples taken from the period 10 to 15 hours includes appreciable amounts of fine grades down to below 200 mesh.

In connection with this experiment, it is of value to record the exact data regarding the nature of the castings cleaned. This has been done in Table II, and an interesting point will be noticed from these results, in that the weight of rejected castings due to defective cleaning steadily increases as the test proceeds.

The results of the grade analyses of samples taken from the circulating grit stream every two hours will be found in Table III. The full duration of this test was 52 hours, and an inspection of the results in this table will serve to show that during this period very little change takes place in the grade analysis of the circulating grit stream. Quite early a small amount of fines, not exceeding 5 per cent. of the two frac-

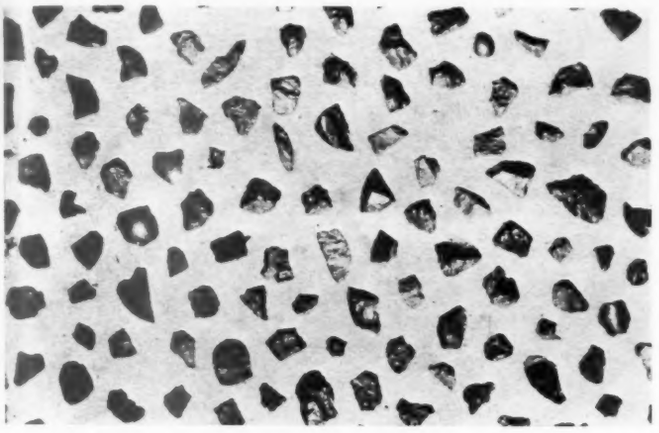


FIG. 1.—ORIGINAL GRIT SAMPLE. (EXPERIMENT 1.) × 4 DIAS.

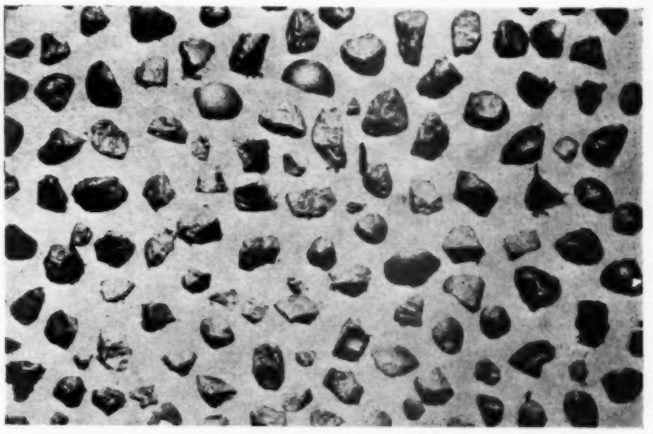


FIG. 2.—GRIT SAMPLE AFTER 8 HOURS' USE. (EXPERIMENT 1.) × 4 DIAS.

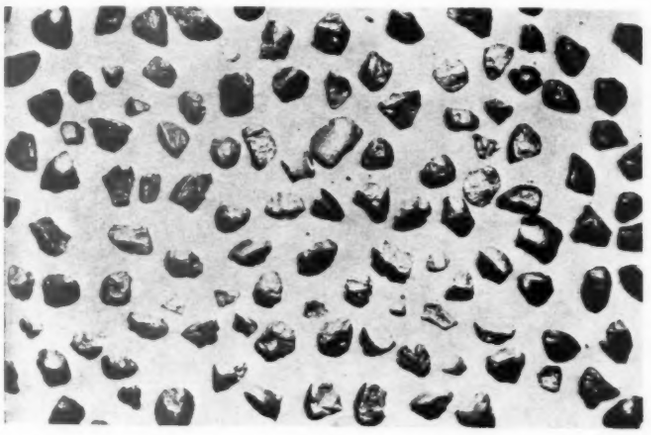


FIG. 3.—GRIT SAMPLE AFTER 14 HOURS' USE. (EXPERIMENT 1.) × 4 DIAS.

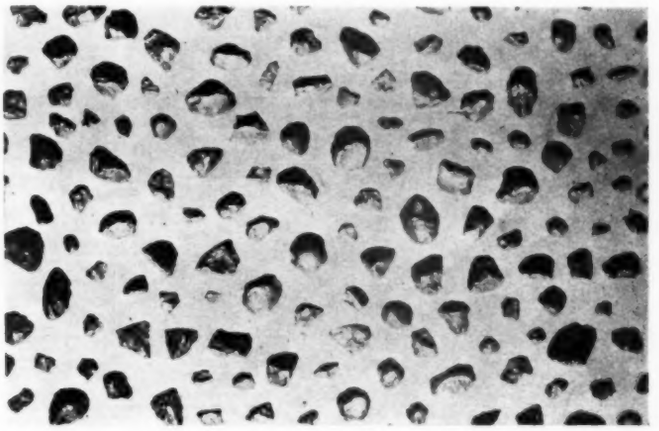


FIG. 4.—GRIT SAMPLE AFTER 28 HOURS' USE. (EXPERIMENT 1.) × 4 DIAS.

It will be felt that this may be explained by some temporary inefficiency in the dust extraction during this period.

The results of the examination under the microscope of samples from the beginning to the end of this experiment compared with the original sample are interesting. They show down to the end of the experiment a distinct loss in sharpness of the edges of the grains. The extent of this is amply illustrated by the microphotographs reproduced in Figs. 1 to 4.

Experiment 2

In this experiment, in addition to samples taken from the circulating grit stream, samples were taken also from the cyclone dust separator coincident with the samples from the circulating stream. A number of additional samples was taken from the exhaust system where the fine dust exhausts to atmosphere. The general data obtained in this experiment are set out below:—

Experiment No. 2.

	Tons.	Cwt.	Qrs.	Lbs.
Total weight of—				
No. 16 angular grit added to machine	—	7	0	0
,, ,, ,, remaining in machine	—	2	1	14
,, ,, ,, used	—	4	2	14
Castings blasted	5	7	3	17
,, rejected after cleaning	—	13	2	26
Nett weight of castings passed after cleaning	4	14	0	19
Weight of grit used—				
Per gross tons of castings cleaned (approx.)	—	—	—	96
,, nett ton of castings cleaned	—	—	—	110

TABLE II.—*Data Obtained from Experiment No. 2.*

Date.	Blasting time.	Running total.	Weight of castings cleaned.			Nett weight of castings cleaned.			Rejects.		
	Hrs.	Hrs.	Cwts.	qrs.	lbs.	Cwts.	qrs.	lbs.	Cwts.	qrs.	lbs.
September 1	2	2	4	1	20	4	1	6			14
,, 1	2	4	5	2	9	5	1	9		1	0
,, 1	2	6	5	3	26	5	2	18		1	8
,, 2	2	8	3	3	23	3	2	25			26
,, 3	2	10	4	2	1	3	3	17		2	12
,, 5	2	12	5	1	10	4	2	10		3	0
,, 6	2	14	4	2	7	4	1	21			14
,, 7	2	16	3	1	6	3	0	17			17
,, 8	2	18	4	1	0	3	3	22		1	6
,, 9	2	20	3	2	9	3	1	21			16
,, 12	2	22	4	0	1	3	2	1		2	0
,, 12	2	24	4	0	5	3	2	17		1	16
,, 13	2	26	4	2	8	4	1	0		1	8
,, 13	2	28	4	2	12	4	1	12		1	0
,, 14	2	30	3	3	15	3	1	14		2	1
,, 14	2	32	4	1	13	3	3	7		2	6
,, 15	2	34	4	1	2	3	2	20		2	10
,, 15	2	36	3	3	10	3	1	7		2	3
,, 16	2	38	4	0	6	3	1	20		2	14
,, 16	2	40	3	2	8	2	3	7		3	1
,, 19	2	42	3	3	0	3	0	7		2	21
,, 21	2	44	4	0	12	3	0	5	1	0	7
,, 21	2	46	3	2	7	2	2	13		3	22
,, 21	2	48	3	1	0	2	0	16	1	0	12
,, 22	2	50	3	0	1	2	1	15		2	14
,, 22	2	52	3	2	2	2	1	0	1	1	2
	—	52	107	3	17	94	0	19	13	2	26

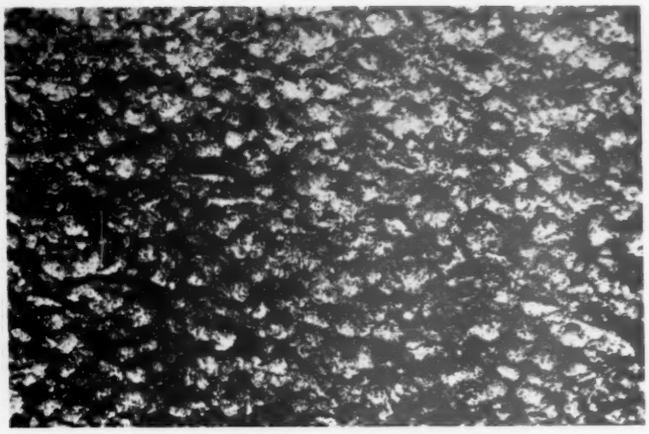


FIG. 5.

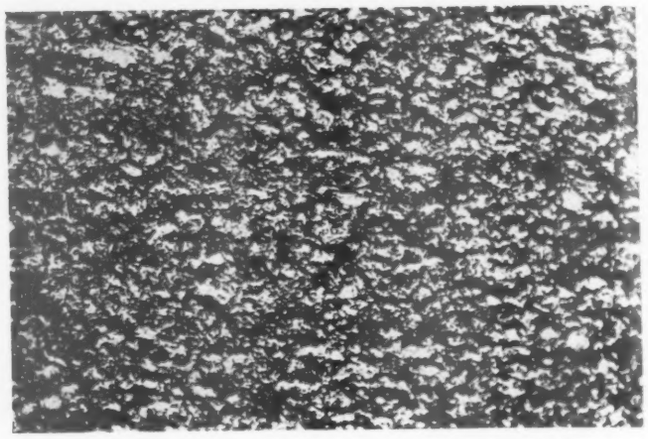


FIG. 6.

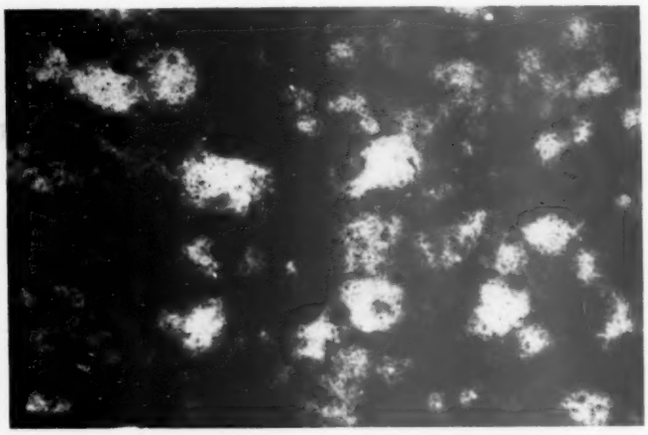


FIG. 7.

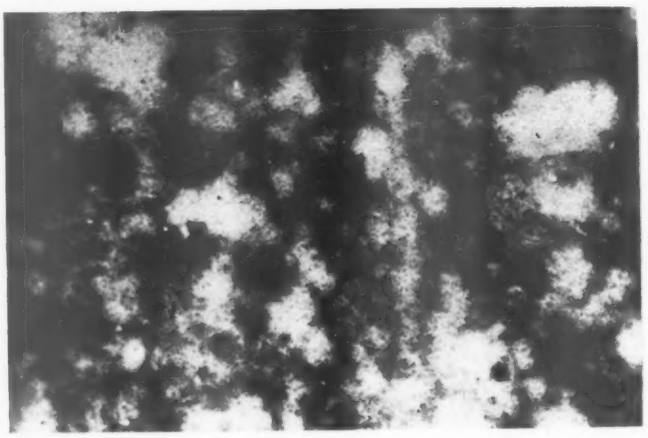


FIG. 8.

FIG. 9.

FIG. 5.—SURFACE OF CASTING CLEANED WITH ROUND SHOT. × 15 DIAS.

FIG. 6.—SURFACE OF CASTING CLEANED WITH ANGULAR GRIT. × 15 DIAS.

FIG. 7.—MOTTLED ENAMELLED SURFACE OF PORTION OF CASTING CLEANED WITH ANGULAR GRIT. × 15 DIAS.

FIG. 8.—MOTTLED ENAMELLED SURFACE OF PORTION OF CASTING CLEANED WITH ROUND SHOT, SHOWING "BLACK SPECKS." × 15 DIAS.

FIG. 9.—MOTTLED ENAMELLED SURFACE OF CASTING CLEANED WITH ROUND SHOT, SHOWING "BOILING." × 15 DIAS.

tions 50 and 60, make their appearance, and it is legitimate to assume that all below this fineness is effectively removed by the dust-exhaust system. Micro examination of these samples gives results identical with those obtained in Experiment 1.

The grade analyses of samples of dust taken from the cyclone coincident with those taken from the circulating grit stream are assembled in Table IV. In this case the grade analyses have been taken after separation of the non-magnetic material. The amount of non-magnetic material in this dust varies in the samples from 0.5 per cent. to 6.1 per cent., the average over all the samples being 2.62 per cent. In other words, approximately 97 per cent. of this dust consists of metallic abrasive, and this dust has been reduced in grade size to an extent that over 75 per cent. of it is below 40 mesh. It is of some interest and importance to note that the whole of the metallic portion of this dust is granular in appearance and possesses sharp edges.

The results given in Table V represent the grade analyses of the dust as it exhausts to atmosphere. There is apparently considerable irregularity in the grade characteristics of this material, but for the most part it will be noticed that it is made up of very fine material, less than 100 mesh. The percentage of non-magnetic material in this exhaust dust is substantially higher and may be regarded as averaging something round 20 per cent.

A visual examination of the non-magnetic portion of the dust shows that it appears to be made up of burnt facing sand mixed with small quantities of other kinds of dirt, such as minute pieces of wood. The dust fused at a temperature of 800 to 850 deg. C. An analysis revealed the iron contents expressed as Fe_2O_3 in Table VI. The results of loss on ignition, which includes the contaminated organic matter, any graphite and any moisture present, are included in the table also. The balance of the dust in each case is mainly SiO_2 originating from the facing sand. It was considered of some importance to investigate the graphite contents, and graphite determinations have been made on selected specimens, with the results as shown in Table VII.

It is extremely difficult to be certain that such small percentages as 0.10 per cent. are actually graphite in the metal as distinct from surface contamination. There is a slight increase in the amount in the grit samples taken from the circulating stream, and a very substantial increase in the samples of the dust from the cyclone. The graphite determinations in the case of the dusts have been made on the metallic portions of the samples after magnetic separation. The authors are of the opinion that this graphite is in the nature of surface contamination, and they hold the view that it has adhered so strongly to the metallic grains in the dust as to resist all attempts at magnetic separation. It is important to note that the extent of graphite present in the circulating grit stream is very small indeed, and it is difficult to believe that such minute percentages can be held responsible for black specks in the final enamel, as is frequently alleged.

TABLE III.—*Experiment No. 2. Grade Analyses of Samples Taken Every Two Hours from Shot-Blasting Machine.*

Hours.	Weight of sample. Grams.	Percentage remaining on sieve No. 12.	14.	16.	18.	24.	30.	40.	50.	60.
Original No. 16 Grit	158	1	17.5	60	6	11	3	15	—	—
2 hours ..	200	0	17	65	6	10	2	—	—	—
4 „ ..	217	0	22	58	4.5	10.5	2	2	1	—
6 „ ..	190	0	15	56	4	14	3	3	3	2
8 „ ..	145	0	14	58	9	15	3	1	—	—
10 „ ..	160	2	11	59	7	12	5.5	2.5	2	1
12 „ ..	150	3	23	61	6	4.5	1.5	1	—	—
14 „ ..	192	1	16	50	7	12	3	2	1	—
16 „ ..	162	0	13	51	7	19	5	3	1	1
18 „ ..	184	0	11	58	9	17	3	1	1	—
20 „ ..	191	1	18	53	8	13	3	2	1	1
22 „ ..	259	1	13	47	7	22	5	2	2	1
24 „ ..	195	1	15	53	9	13.5	4.5	2	1	1
26 „ ..	134	0	5	50	10	20	7	4	2	2
28 „ ..	176	0	16	50	8	18	5	2	1	—
30 „ ..					No sample					
32 „ ..	207	1	20	56	5.6	23	2.4	1	1	—
34 „ ..	182	1	8.5	46	8.0	20.5	6.5	4.5	3	2
36 „ ..					No sample					
38 „ ..	130	1.5	17	50	8	20	3.5	0	0	0
40 „ ..	100	2	15	52	8	18	3	2	—	—
42 „ ..	160	1.2	18.5	50	10	17	2.5	0.8	—	—
44 „ ..	172	1	19	52	7	17.5	2.5	1	—	—
46 „ ..	182	1	14	48	9	22	4	1	1	—
48 „ ..	212	1	5.5	45	11.8	31.7	5	—	—	—
50 „ ..	200	2.5	15	42.5	8.5	20	5	3.5	1.5	1.5
52 „ ..	237	2	16	47	8.5	17.5	4.5	3	1.5	—

TABLE V.—*Experiment 2. Grade and Magnetic Analyses of Samples of Dust taken from Exhaust Roof.*

Hrs.	Wt. in grams.	Percentage remaining on Sieve No. 14.	16.	18.	24.	30.	40.	50.	60.	100.	150.	200.	—200.	Percentage non-magnetic top of exhaust.
16	10	0	0	0	0	0	0	0	0	10	40	30	20	23.70
20	—	2	8	3	6	3	4	10	16	30.5	9.5	4	4	0.88
24	11	0	0	18	4.5	4.5	9	9	9	18	14	10	4	3.15
28	7	0	28.1	7	3.9	3.9	4.1	4	21	14	7	7	7	7.40
32	3.07	0	4	0.7	5.6	3.9	5.6	9	8.3	27	12.3	5.6	18	23.10
36	3.15	0.7	1.6	0	4.6	4	3.2	5.6	4	11	9	13	44	23.10
44	0.90	0	0	0	0	0	0	0	0	2.2	8.8	10	79	18.80
48	2.14	0	0	0	2.4	2.4	4.2	9.0	8.0	28	11	8	27	9.5
52	0.70	0	0	0	0	0	0	2.7	2.7	2.8	5.4	5.4	81	5.4

TABLE IV.—*Experiment No. 2. Grade and Magnetic Analyses of Samples of Dust Taken from Cyclone.*

Hrs.	Wt. in grams.	Percentage remaining on sieve No. 16.	18.	24.	30.	40.	50.	60.	100.	150.	200.	—200.	Percentage non-magnetic material.
2	80	0	1	4.5	6	27	22.5	12	15	9	3	0	2.6
4	60	0	0	2	3	12	20	12	22	20	5	4	2.8
6	87	0	0	1	4	11	18	12	31	18	3	2	6.1
8	80	0	0	3	5	15	26	16	17	10	5	3	2.4
10	85	0	0	3	3	16	15	14.5	30.5	11	4	3	3.5
12	69	0	0	2	3	13	24	13.3	13	12.7	10	9	
14	60	0	0	2	2	8	18	17	18	23	7	5	3.8
18	100	0	0	1	1	12.6	26	14.4	30	10	3	2	5.1
20	110	0	0	0	0	6	32	22	22	12	4	2	1.55
22	159	0	0	1	1	12	25	15	30	10	4	2	0.85
24	17	0	0	0	6	18	30.4	18	17.6	8	1	1	0.66
26	125	0	0	1	4	23	30	15	20	5	1	1	0.65
28	100	0	0	4	5.1	23	24.9	8	17	10	4	4	0.51
30							No sample.						
32	112	0	0.9	0.9	2.7	18.8	29.5	15.1	24.2	6.1	1.8	0	1.78
34	20	0	0	0	5	15	25.5	9.5	25	10	5	5	1.1
36							No sample.						
38	64	1.6	0	3.1	7.8	16	23.2	12.8	26.3	6	1.6	1.6	2.95
40	75	1.3	0	4	8	20	24	13.4	24	4	1.3	0	2.70
42	95	0	0	2.1	3.2	15.8	24	15.8	28.5	7.4	3.2	0	2.4
44	117	0	0.9	2.5	4.2	15.2	23	23	27	4.2	0	0	2.75
46	100	0	1	2	7	20	20	15	25	5	3	2	3.54
48	105	0	0.9	1.9	6.8	21	20	11.3	26.6	9.6	1.9	0	3.3
50	95	0	0	2.2	6.5	21	21	15.8	25	5.2	3.2	0	2.55
52	115	0	0.9	1.8	4.5	14.1	19	14.8	32	8.7	2.4	1.8	3.95

TABLE VI.—*Experiment 2. Analyses of Samples of Dust from Cyclone.*

Sample no.	Description.	Per cent. iron as Fe_2O_3.	Loss on ignition.
8 hours ..	Cyclone	18.4	1.20
32 „ ..	„	16.2	Nil
42 „ ..	„	14.0	3.40
48 „ ..	„	30.6	Nil
	Exhaust (mixed) ..	27.0	1.00

TABLE VII.—*Experiment 2. Graphite Determinations of Various Specimens.*

Sample description.	Graphite carbon. Per cent.
New grit before use	0.10
Grit from circulating stream after 8 hours	0.16
„ „ „ „ „ 42 hours	0.16
Dust from cyclone after 18 hours ..	0.60
„ „ „ „ 38 „ ..	0.44
„ „ exhaust after 36 hours ..	0.60

Round Shot

It has been the intention of the authors to explore the behaviour of round shot when used under conditions identical to those outlined in Experiments 1 and 2. Trials were started using No. 30 round shot, but they had to be abandoned at the outset because of the completely unsatisfactory results obtained from a cleansing point of view. The castings after cleaning with round shot were found to be utterly unsatisfactory on enamelling, the enamelled surface being affected by "black specking" and "boiling." This result might have been anticipated, as this experience has been recorded previously. However, as photographs of the results obtained were made it was considered to be worth while placing these on record. Fig. 5 shows the surface of the casting at a magnification of 15 diameters after cleaning with round shot, and for comparison a photograph of a similar casting cleaned with angular grit is included in Fig. 6. The photographs show a very marked difference in appearance. The surface cleaned by the round shot is discarded by those familiar with it as a "peened" surface, and, on close inspection, whilst apparently the surface skin is removed, the surface appears to be full of small spherical depressions, and one gains the impression that the casting skin has been partly broken and forced or peened into the surface rather than having been removed. In the case of the surface cleaned with angular grit the surface is clearly cut, and visual inspection gives one the impression that the casting skin has been cut away.

The photographs Figs. 7 and 8 are from two portions of the same casting, the portion represented by Fig. 8 having been blasted with round shot and the other portion with angular grit. The presence of black specks in the portion treated with round shot, and the absence of these black specks in the other portion, is shown clearly. A photograph from another of the same batch of castings treated with round shot is shown in Fig. 9. The pronounced "boiling" of the enamelled surface is clearly indicated. All these photographs were taken at a magnification of 15 diams.

Summary

These investigations have demonstrated that the circulating stream of No. 16 metallic grit as used in the ordinary room-type blasting machine undergoes disintegration into finer particles and those below 40 mesh are extracted almost completely by the dust-extraction system. The circulating stream of grit remains almost completely free from non-magnetic material, showing that this is almost completely separated by the dust-extraction system. The grit remaining in the circulating stream shows considerable wear of the sharp edges, but in spite of this the grains always remain rough and reasonably angular. The percentage of free graphite remaining in the circulating stream is negligible, and this, along with the non-magnetic portion of the dust, finds its way immediately into the dust-extraction system.

The major portion of the disintegrated grit is collected in the cyclone separator, and this all possesses fine sharp edges. The non-magnetic portions of the dust are mainly so fine in character as to be carried right through to the exhaust, only something of the order of 2 to 3 per cent. average remaining in the cyclone dust separator. The non-magnetic portions of the dust consist essentially of sand and iron oxide with some graphite and organic matter.

Round shot produces a completely different surface finish from grit. This surface is best described as a "peened" surface and is invariably associated with defects in the finished enamelled surface. These defects are "black specks" and "boiling."

Finally the authors wish to express their thanks to the directors of the Parkinson Stove Company, Limited, and Bradley & Foster, Limited, for the facilities placed at their disposal for carrying out the investigations and their permission to publish the results. Their thanks are due also to the British Cast Iron Research Association for their examination and the photographs Figs. 5 to 9 of the defective enamelled surfaces due to round shot.

Scientific Aids to Control in Vitreous Enamelling

At the annual conference of the Institute of Vitreous Enamellers, held at the Hotel Normandie, Knightsbridge, London, a Paper on "Scientific Aids to Control in Vitreous Enamelling" was presented by Mr. J. G. Pearce, M.Sc. (Director and Secretary, British Cast Iron Research Association), and Dr. G. T. O. Martin (The Institute's Research Officer). This was published in our issue of November 3.

Scope of the Paper

MR. J. G. PEARCE, introducing the Paper, said he had not been to America so recently as some members of the Institute, but when he had visited that country he had been much impressed by the aid which was being given to the vitreous enamelling industry, dealing with the enamelling of both sheet and cast iron, by a series of appliances which he had found to be in universal use among frit makers and in certain respects among the actual enamellers themselves. The Paper described some of those types of apparatus which had been designed either for use in preparing new types of frit and evaluating their properties, or in testing or controlling the finished product. The Paper did not pretend in any way to cover the control of raw materials or control the process as such.

Mr. Pearce emphasised very strongly indeed that the authors would very much prefer to use and recommend British apparatus where it was available. Since writing the Paper they had come across one or two pieces of British apparatus of which he was not previously aware, and the use of which was not so readily apparent as was the use of their opposite numbers in the United States. References by speakers to apparatus which might be applied to the enamelling industry would be very greatly appreciated. There was no doubt, however, that the size of the American enamelling industry and its output, the magnitude of the larger frit-making and frit-using firms, combined with what might be called a natural predilection for using instruments where possible, gave the United States in that respect a very special advantage.

In this country he had found a very strongly expressed feeling among enamellers that the time was ripe for some measure of standardisation of the instruments and methods of control, so that all engaged in the industry could speak in the same units.

DR. MARTIN, who summarised the Paper, said that if we had in this country some standards such as those used in the U.S.A. they would be of very great help to the industry. With regard to the measurement of the thickness of enamel layers, he said the authors had heard of instruments other than the G.E.C. thickness gauge (as described in the Paper) for that purpose, but at the time the Paper was prepared that was the only one of which they were aware which made the measurement in a simple way on the final product.

He had been interested to find, when in Scotland, that the thermal expansion of the enamel was being measured, though not by the method described in the Paper. A knowledge of the expansion of the enamel over the whole range of temperature to which it was subjected could be very useful. That was a case where practical experience could blend very well with theoretical principles. Work had been done in Germany and this country, as well as in America, on the problem of adherence, and he was anxious to secure information concerning work which had not been published in the technical journals.

DISCUSSION

A British Thickness Measurer

MR. W. H. TAIT (International Tin Research Council) said that in connection with the measurement of the thickness of tin coatings on steel the problems encountered were very much the same as those concerned with the measurement of the thickness of enamel coatings; and in the case of sprayed tin coatings the thicknesses were very comparable with enamel coatings. He discussed an electrical instrument he had devised for measuring the thickness of tin coatings; in some respects it was not unlike the American thickness gauge mentioned, but in others it differed, and in some ways perhaps it was more suitable for the work. It was rather simpler and less expensive, and it did not need an absolutely flat surface; it would give accurate readings on a curved surface. He had had very little opportunity, however, to try it on vitreous enamel, but such tests as had been made were entirely satisfactory.

The instrument was of the workshop type, and did not involve the destruction of the piece under test. Unless the steel was extremely unusual, it was not necessary to make corrections for the steel base, but obviously it would be necessary to have a different calibration for cast iron. He did not know how cast irons varied one from another; but in the ordinary mild steels used for spraying there was no variation of any importance. The instrument was being made in this country by the Salford Electrical Instrument Company, part of the [British] General Electric Company, and it had been on the market for measuring sprayed tin coatings, but he did not think it was on the market yet for measuring vitreous enamel coatings.

Difficulties of Assessing New Frits

MR. S. R. WITT (British Thomson-Houston Company, Limited, Rugby) said he felt sure that as the various methods of measurement discussed became more widely applied, vitreous enamelling would make great headway. He personally was concerned with the production of home appliances; and although vitreous enamelling was very important in that sphere, there were other processes involved, such as by paint finishes, metal spraying, plating, and heat-treatment of metals. Bearing in mind the progress which had been made during the last five or six years as a result of the introduction of precise methods of measurement in connection with heat-treatment and other processes, one must admit that vitreous enamelling lagged a long way behind in regard to scientific control, although, of course, one appreciated the difficulties of applying such control.

As a user of frits, he was asked from time to time by enthusiastic manufacturers to try their various frits, and, quite frankly, in most cases, it was almost impossible to reach decisive conclusions from such experiments. The difficulty was one of ensuring that a small trial batch of work enamelled with a new enamel was being processed under optimum conditions, otherwise conditions prevailing for the standard enamels and other variables could more than offset any advantages. If, on the other hand, the manufacturers could state the properties, such as reflectance, impact value, and so on, this

data together with the price would enable one to judge whether or not the enamel was suitable for the particular application. One could save the time and money spent in testing it out.

It was interesting to note the references in the Paper to both alkaline and acid resistance of enamels. One heard a lot about acid resistance; but he was concerned with the manufacture of washing machines alongside cookers, and the answer to resistance was not always a lemon! The soap manufacturers sent out wonderful soaps which were claimed to do great things, but what happened to the vitreous enamel on the apparatus used? He felt enamels were required which would enable the same mill batch to be used for a cooker or washing machine—and indeed, that need was apparent, because we should have to provide kitchens such as those in America, in which the colour must be the same all the way through; so that there was a demand for an enamel which was chemically inert. Regarding enamel rather as a glass, the resistance of chemical beakers, in which one could place either acid or alkali, was a necessity.

He had hoped that Mr. Tait would have described his instrument for thickness testing. He asked whether it was a magnetic test or was equivalent to an air gap.

How the Gauge Operates

MR. TAIT replied that it was an electro-magnetic test. The coating formed an air gap in the magnetic circuit of a small transformer, incorporating a U-shaped core with a primary on one arm and a secondary on the other. Through the primary of this transformer a constant current was passed, and the voltage induced in the secondary gave a direct indication of the thickness of the coating.

Thickness Gauging and Colour Matching

MR. S. HALLSWORTH said that quite a number of improvements had been effected in vitreous-enamelled goods during the last five years: much work had been done on the composition of enamel, involving work and worry on the part of the enamellers. It would, however, take a considerable time to produce enamels to give anything approaching the desirable results envisaged by Mr. Witt. Enamel was a glass: unfortunately, it was a glass which had to be applied to metal, and, therefore, quite a number of troubles were experienced which would not arise if the industry had merely to manufacture the glass alone.

The gauge for measuring the thickness of enamel coatings seemed to be a very useful instrument, and it was of great advantage to be able to measure the thickness of enamel and to correlate it with the results of opacity and other tests. It would also be very useful during investigation work on chipping, crazing, etc. He asked those who had visited America whether the thickness gauge was actually used in works' practice and whether plates were rejected before reaching the assembling shop in the event of the thickness of enamel being greater than that which was specified. It was quite possible to get a difference of as much as 20 per cent. in the weight of enamel applied by different sprayers.

Colour matching was important, but he was doubtful whether 2,000 or 3,000 plates per day could be examined to ensure that the colour of each plate matched with a standard. It was possible to match each mill-batch of enamel in that way and any form of control showed a definite improvement in efficiency and economy. At one works recently visited some very high-powered daylight globes were used in the room in which the finish of the assembled enamelled components was inspected, yet in the enamel department where the individual plates were inspected the light provided was inferior. He was strongly in favour of any apparatus or appliances which would improve the quality and appearance of enamelled goods by the technical control of material and processing.

A New British Gauge

A MEMBER said that at one British works an enamel thickness gauge was in use regularly, and it had been patented by the firm concerned. It was rather similar to the American thickness gauge mentioned in the Paper, but in some respects was simpler. It did not need a supply of alternating current, as he believed was needed by the American gauge, but could be worked directly off a 2-volt accumulator. The principle was that of comparing enamel thickness with an air gap, as in the gauge mentioned by Mr. Tait. Though it was not exactly a transformer system, the comparison was made by the back e.m.f. produced on making and breaking the circuit. He had found the instrument to be very easy to use, and it gave accurate results. It was checked by using sheets of glass of known thickness and checking with a micrometer, and it was found that both with sheet steel and cast iron there was no alteration in the calibration. The accuracy of the results was within 2 per cent. He did not think it was the intention to use that instrument on every enamelled piece to maintain a check on each one, but rather to make an occasional check to show how the sprayers were applying the enamel; if anything went wrong the management could find out more or less which spray was the cause of the trouble.

Acid Resistance Evaluation

Those in charge of the works in question were keen on making measurements of the various properties. They had tried to measure acid resistance by a method he had never seen mentioned in any literature, *i.e.*, by measuring the amount of attack on the surface by the chemical activity of the attacked surface. The attacked surface, etched by acid, would actually decompose a certain salt, as, for instance, lead acetate, and the decomposition was attributed to the formation of lead hydroxide. Whether or not that was the true explanation he was not sure, but the method had worked, up to a point. They had not proceeded very far, because it did not appear to be leading anywhere, but it was worth further investigation. A method of measuring acid resistance by the extent of attack on surfaces would be very useful, and if the method he had described would work and could be refined, it would be a fairly simple one.

Empirical Tests

DR. MARTIN, in reply, said the acid resistance test was the type of thing that needed investigation with a view to development. At first sight it did not appear that it would express results quantitatively; it might be applied as a "yes or no" test, or there might be three or four gradations, but it did not appear to be the sort of thing to which one could apply a very good scale. In a test which was actually in use by a firm in this country, the surface of the enamel was etched by acid, and then a coloured solution was applied to it and allowed to dry in; subsequently the ease or otherwise with which the mark could be removed was determined. This test could be applied to coloured or black enamels. A quantity of white enamel was used in U.S.A., and most of the methods were based on white enamel; it was rather interesting to note that they did not appear to be concerned much about the acid resistance of black enamel.

American Sheet Quality

MR. B. B. KENT said that the members of the Institute who had visited America recently had not noted any markedly large application of scientific instruments by those who were doing the actual enamelling; but such instruments were used by the frit makers. Apparently the apparatus for measuring the thickness of enamel was used by the frit makers to improve their own enamels, and that fact was used in sales propaganda. The sheet iron used by the enamellers in America was of very much better quality than that supplied in this country. That was not the fault of the English makers, but was due to the fact that the deposits of ore in America were superior to those in this country. At the same time, he had noted at the conference in America that the enamellers blamed the iron just as much as British enamellers did.

MR. HALLSWORTH said he had seen it stated in print that all the plates were inspected for thickness, and that plates which were of more than the specified thickness were rejected by the enamelling shop. He asked whether any members of the Institute had noted this in America.

Pressed Steel Enamelled Baths

MR. J. H. GRAY, who was among those who had visited America, said that the party had visited about 13 plants, and the only one of the enamelling firms in which he had seen instruments used to control the thickness of enamel was that of Briggs' Bodies, in Detroit. It seemed that they had adopted that policy because the manufacture and enamelling of pressed steel baths was comparatively new, and they had to be certain that the finished job would stand up equally well as or better than the cast-iron porcelain enamelled bath and also the ceramic bath. He had not, however, seen these instruments used for control in any of the other enamelling plants. The bulk of the control instruments were used by the frit manufacturers, and one or two of the enamelling firms which were making their own frit also had a few instruments.

DR. MARTIN said that statements such as had been referred to by Mr. Hallsworth had appeared in print. The Paper mentioned in reference No. 7, at the end of the Paper by Mr. Pearce and himself, was by an enameller, and not by a frit manufacturer.

Testing Related to Quality

MR. KENNETH HILL supported Mr. Pearce's plea for further investigation into the pressing of steel shapes suitable for enamelling. He recalled a very comprehensive and interesting Paper* by Mr. J. H. Coupe on that topic, and he suggested that the Institute might very well investigate it.

Apropos the remarks of various speakers concerning the use of instruments in America and the quality of American enamelling, he said he had been to America himself and had discussed the matter with others who had been there, and was convinced that so far as quality was concerned we had nothing to learn from America; the quality of enamelled ware in this country was in any number of cases superior to the American. The use of the complicated instruments which had been referred to was no doubt necessary in view of the fact that the output of the American industry was so huge as compared with British, and he failed to appreciate how methods which were necessary for huge productions could be equally necessary or efficient in cases where the production was necessarily very much smaller.

Theory and Practice Divorced

MR. A. ENGLAND, M.Sc., who supported Mr. Hill's remarks, recalled a visit he had made last year to Canada, where he had visited about half a dozen works, and said he had learned nothing there that he could not have acquired at home. In conversation with the research director at one large works, the latter had remarked that it had been a pleasure to discuss problems of the industry with a man possessing both scientific and practical knowledge, for there were few such men there. On the one hand there were the university professors and others who evolved and conducted tests, and on the other hand there were the practical men, who simply laughed at those tests. Mr. England said he mentioned that in order to show that, in the enamelling industry on the other side of the Atlantic, the practical work was perhaps not so

* FOUNDRY TRADE JOURNAL, November 5, 1936.

closely associated with the scientific and theoretical work as one might be led to believe.

If the Institute of Vitreous Enamellers could do something in regard to tests to develop quality in relation to sales, it would do a great deal of good. The result would be to bring the best enamels to the top without the help of sales talk; the members of the Institute were interested in ensuring that Britain produced the best products.

The problems of opacity, reflectance and gloss were rather badly mixed up; it would appear from the Paper that enamellers did not know where they were, and that differentiation was required. It had been said that English frit makers did not know how much enamel to use in order to get a definite opacity; but the firm with which he was associated, at any rate, carried out opacity tests for a given amount of enamel on a given area.

A matter which disturbed him was that so many people seemed to assess the value of enamel by its gloss, and he emphasised that too much importance might be attached to that factor. There were many other attributes in an enamel. After all, gloss could be imparted by adding borax, but it did not enhance the value of the enamel.

Thermal Expansion

The problem of thermal expansion had always interested him greatly, and although much was said about the work done in that connection in America, it was surprising that no reference had been made at that meeting to the value of the work which had been done in Germany. In that connection he recalled that more than 20 years ago, when he was working on thermal expansion problems, he had been introduced to a book on Jena glass by Dr. Hovestadt, in which the experiments carried out by German and other workers were discussed.

Cross Bending

The cross bend test applied by most enamellers in this country was to bend enamelled sheet over a 1-in. diameter round bar at right angles, so that the bend had a radius of ½-in. If the enamelled sheet would withstand that treatment it was assumed that the adhesion of the enamel was fairly reasonable. The result obtained with a 26-gauge article was very different from that obtained with an 18-gauge article, however.

It would be of great value to be able to establish some standards of acid resistance, and it was up to the Institute to put forward those standards. In America there was a demand for a test in 10 per cent. cold citric acid for half an hour, or, if the medium was required to be boiling, they asked for 1.5 per cent. malic acid and 1.5 per cent. citric acid. On the other hand, he had carried out a satisfactory test with 10 per cent. citric acid boiling for 100 hours. It was time, therefore, that standards were established.

The Alkali Resistance Problem

With regard to alkali resistance in white dusted enamels, the position was really serious, having regard to the nature of some of the cleaning materials available. Recently a cleaning material was analysed and was found to contain 3 per cent. of soda carbonate and 1.5 per cent. of caustic soda, the body being soap. A solution of soap had been made and the soda had been boiled in it. When a complaint was made that an enamel was not a good one, therefore, it was advisable to find out what material had been used to clean it.

Although nothing had been said about the workability of the enamel in the shop to produce standards, he urged that that was one of the most important factors, and that in establishing standards there should be real co-operation between those who were establishing the standards and those concerned with the actual workshop practice. Anyone could make an acid-resisting enamel; but what was the use of it if it dropped to the bottom of the vat immediately it came out of the mill?

MR. B. B. KENT expressed agreement with the remarks of Mr. Hill and Mr. England concerning the qualities of English and American enamelling, and recalled a statement by Mr. Stone that the quality of the enamelling we could do in this country was quite as good as, if not better than, that produced in America. In cast iron enamelling Britain was definitely ahead of America, and that was also the case in regard to acid-proof enamel. But, according to his observations on his recent visit and on previous visits to America, the general standard of articles produced in America was very considerably higher than the average standard in this country.

The Research Programme

MR. W. S. GRAINGER pointed out that the members must appreciate the fact that the Paper was only intended to be a *résumé* of some of the work that had been done in connection with the testing of the physical properties of enamels, and upon which the Technical Committee intended to devote some considerable thought in the future. In reply to a former criticism, he said there was no point in making comparison and contrasts of the quality of enamelled ware produced in this country and America. He wanted an accepted standardised opacity test which all in this country could use for the checking of their enamels, and he wanted a standard method of bending where a certain gauge of plate carrying a certain thickness of enamel was bent round a certain size of bar, knowing that the rest of the industry was making comparative tests in exactly the same manner. He hoped that before very long it would be found possible for the Institute to determine these standards and to evolve satisfactory methods of carrying out these tests.

Necessity for Standards

MR. J. H. GRAY said the point that mattered was that frit manufacturing and other concerns in America were using the scientific instruments mentioned, and they were establishing standards and methods of control. The enamels of this country were all very much the same, and he felt that if standards were set his enamels would be altered, and others would alter theirs, so that they could all work together within reason. Then we need not worry about other countries, for we should know that we were maintaining our standards and producing enamelware of good quality. He urged that the discussion should be directed to the matters that could be dealt with by the laboratory facilities of the Institute.

DR. MARTIN remarked that the U.S.A. had been referred to so much because a number of members of the I.V.E. had visited that country recently, and Mr. Pearce had visited that country earlier. Maybe, when visits had been made to Germany, they would be able to say what was being done there.

MR. GRAY said he was urging that British enamellers should not worry about other countries, but should set their own standards and adhere to them.

Reflectance and Opacity

MR. J. T. GRAY, discussing reflectance and opacity, said that they were two distinct qualities. One could produce a white enamel of a very high degree of opacity, but which would fail in the reflection test, and he mentioned a leading firm producing reflectors to a given reflection standard, to obtain which they had to use a semi-opaque enamel, because the opaque enamels did not achieve the required standard of reflection. Various factors, such as colour, whether a colour should be warm or cold, had a definite bearing on the opacity required. In discussing the future work of the Institute in establishing methods of control and standards, it was necessary to know first the requirements of the industry. For example, it was useless saying that an enamel of high opacity was required, because the degree of opacity required depended on the use to which the enamel was put; one enameller required an opaque enamel, whilst another required an enamel which was semi-opaque.

Narrowing the Issue

MR. R. W. WHITTLE urged that if the various problems under discussion were dealt with one at a time, we should arrive at standards within a reasonable period, but if the attempt were made to deal with twenty things at once we should never get anywhere. The speed at which the industry was developing made it necessary that conclusions should be reached fairly quickly. He suggested that every enthusiastic enameller in the Institute should contribute something to the Institute by way of a proposed standard, indicating what he had found by experience to be the best to apply. If that were done, then within five years the Institute would establish a series of standards which would be well worth while.

British System of Control

MR. C. P. STONE, who also had recently taken part in the visit to the United States, where a number of plants had been inspected, emphasised that the instruments that had been seen in use were necessary by reason of the huge quantity of goods manufactured. In all cases, these instruments were in the laboratories of the frit makers. One would imagine from the Paper under discussion that the industry in England did not test at all, and that it had no scientific apparatus, but, in fact, English frit makers and, in the main, large makers of domestic apparatus who manufactured their own enamels, had their own means for checking results to their own satisfaction, and that of the customers.

The tests in most cases were simple, quick and effective, sometimes not with the swiftness of the electrical recording instruments described in the Paper, but they were satisfactory, and because of their simplicity were used more often, and were not nearly so costly. He, in common with other makers of repute, was manufacturing enamels on a quality basis, and did not send out frits for customers' use without their being thoroughly tested in the laboratory, both before and after they had been tested in a proper test-muffle plant, which was maintained in the works for that purpose on a practical scale, being operated by skilled workpeople, the result being checked by the laboratory, so that, in each case, the results obtained could be repeated on a large production scale.

"Birmingham" Standard

It had been stated by people he had met in America that the various instruments were necessary, particularly with firms which sometimes used as much as 20 tons of frit per day. The head of one very large plant had said that his never-ceasing plea to his people was that the goods produced should be of the quality obtained in Great Britain, or, as he called it, the "Birmingham standard."

The American plants had very fine quality sheet metals, specially manufactured for their use, and it was almost free from distortion.

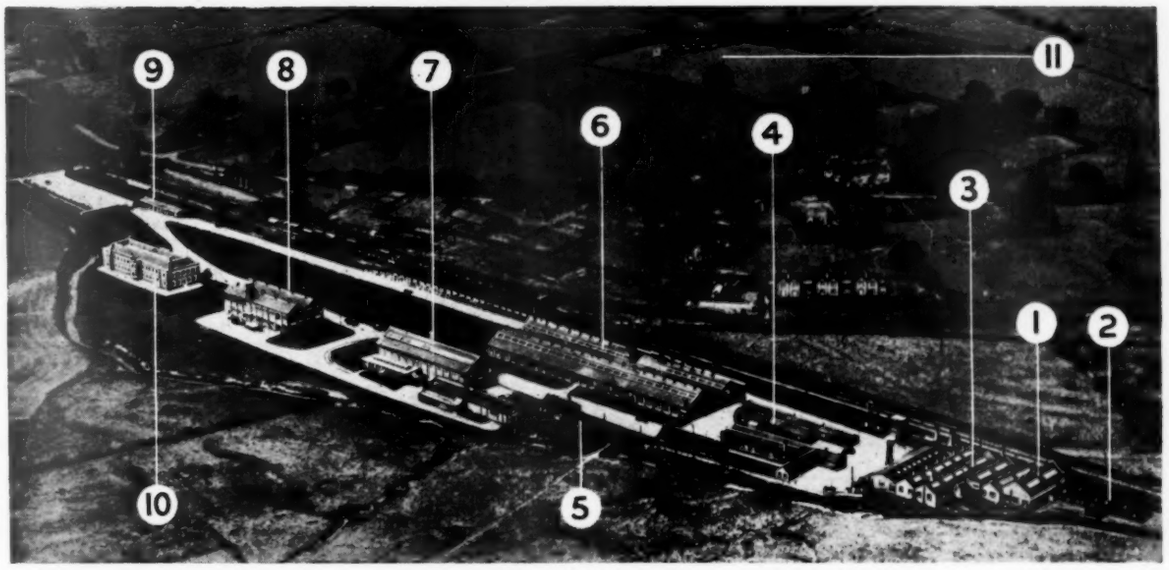
Mechanical Handling

They did not hesitate to spend large sums of money on tools, even though often they could not possibly get the money back, but gambled on a repeat of the order. It might be that this was because of the shortage of skilled labour, but it was certain, in one instance, where £1,500 had been spent on a machine, that the order could have been produced by hand for a fraction of the above amount. America was undoubtedly mechanically minded, and it was found that where one plant was using a conveyor furnace, their neighbour would also be anxious to install one, although often they would close down for a considerable period.

Antimony and Lead

A point of outstanding importance with regard to enamel in the American industry was that there was no bar to the amount of antimony that could be used. In this country, it was looked

PROGRESS that speaks for itself



F. WILDBLOOD, *Chairman.*

"To our numerous friends in all branches of the Ceramic Industry, I thank you for the confidence you have placed in our products which has enabled us to build up this business.

Our sole aim has been to supply reliable goods at reasonable prices—to give a square deal to our employees—and I feel grateful to you all for any success we may have achieved."

PROGRESS THAT SPEAKS FOR ITSELF

1 *Original works* 1908 *worked by water wheel.*
2 *Extension of brick building by one bay and added an Army Hut* 1919.
3 *Extension by* 3 *additional bays* 1927.
4 *New Laboratories and Offices* 1928.
5 *Tin Oxide Plant* 1930.
6 *First bays of new colour works* 1930.
7 *New works for the production of Vitreous Enamel* 1934. *Extended* 1935.
8 *New Glaze Works* 1937.
9 *New entrance to works and garages* 1937.
10 *New Offices* 1938.
11 *Sports Ground with cricket pavilion* 1926. *Tennis Pavilion* 1936.

Manufacturers of COLOURS, STAINS, OXIDES, BASES, ENAMELS, GLAZES, LUSTRES, SIZES AND OILS FOR POTTERS, VITREOUS ENAMELLERS, MANUFACTURERS OF CERAMIC TRANSFERS, GLAZED BRICKS, TILES, GLASS, PAINT AND ARTISTS' COLOURS.

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P 2b

upon with a great deal of suspicion, and rightly so. In the hollow-ware trade it was not permitted. Also lead was used freely, particularly on cast iron. One had to bear in mind, however, that the climatic condition of America, where air was dry, was vastly different from England.

American manufacturers of cookers, etc., would be horrified if supply authorities demanded a life of 10 years from their goods. It was claimed that American people had adopted the habit of changing their cookers almost as frequently as they changed their motor-cars, and their apparatus was calculated, when constructing them, to conform to this practice.

The Enamelled House

They also spent a great deal of money on propaganda and were constantly looking for new fields, the latest being the enamelled four-roomed house, which it was expected would create a huge demand, and would sell at the equivalent to £750. In England the house would be designated "jerry built." To show the difference in climate, one of the plates on the house inspected had been chipped, and the iron had been exposed for about 14 days, but had not shown any sign of rusting. Very definitely in England, owing to humid atmosphere, a similar exposure of the metal would have rusted in 14 hours. Thus, quality and durability had become the slogan of English manufacturers, to satisfy the demand of the supply authorities, and to suit English requirements.

"Blinded with Science"

One of the difficulties, it was learned in America, was that though a great deal of scientific work was done in the laboratories of the universities and plants, the industry did not reap the full benefit in practice. In the course of the lectures at an American University, members at the annual conference had said that they were being blinded by technicalities of the lectures, and they pleaded for something practical that would be of assistance to them in their own plant. The lectures dealt with had embraced such shop troubles as chipping of enamels, black specking, colour matching and fishscaling. Technical explanation was put forward by the lecturer, but this, it was stated, did not help the average enamellers to deal with the trouble. Undoubtedly, the skilled technician must also be a practical enameller.

Attention had been called, in the Paper presented, to the scratch test, and it was important to remember that shop practice and firing conditions played an important part, as the resistance of any enamel would be affected according to the way it was fired.

Colour Standards

An endeavour was being made to standardise the colour of white in the United Kingdom, but he had always found that all firms of repute had their own ideas on this question. Some liked a cream-white, to conform to their design and the general colour scheme, whilst others making a similar article would like a blue-white, irrespective of the amount of enamel on the article, so that standards of whiteness varied considerably.

As to whether or not frit makers and manufacturers generally were applying the correct tests to their products, he said that the fact that the quality of British enamelled products was still unrivalled provided an answer, in spite of the fact that a large quantity of the sheet work was enamelled on low-grade steel, and the designs of the parts were not all that could be desired. Constant endeavour was being made by practical enamellers, checked by expert technicians in the laboratory, and laboratory results were proved on actual plants, on a mass-production basis, to the satisfaction of the enamellers and the consumers alike.

Quantitative Expression

DR. MARTIN, commenting on Mr. Stone's point that the frit manufacturers in this country tested their frit before it left the works, fully agreed that this was so. But the great consideration was how the frit manufacturers were to agree as to the standards that should be attained and how to express the results in figures. Were they satisfied that the tests they were using were the tests that were of the greatest use? He believed it was mentioned in the Paper that it was unlikely that some of the instruments described would come into regular works' use. The chief point in describing them was to indicate how useful they would be in a laboratory.

Useless Comparisons

The CHAIRMAN (Mr. W. H. Whittle), at the conclusion of the discussion, commented that the comparisons made of British and American practice seemed to result from misunderstanding of the purpose of the Paper, which was to stimulate discussion, having regard to the Institute's decision to form a research organisation. There were few references to America in the Paper, and those references were due to the fact that Mr. Pearce had visited America and had seen there some of the instruments described. There was no intention on the part of the authors to claim that any one method was better than another, or that the practice of one country was better than another. Each country had its own climatic conditions, labour conditions, Factory Acts, etc., so that one country could do things which another could not do. But the Paper did indicate some of the lines on which the American industry was progressing, and it had served to stimulate discussion.

Vote of Thanks

A hearty vote of thanks to the authors of the Paper was proposed and seconded, and was supported by MR. W. S. GRAINGER, who expressed the hope that the Paper would be received in the spirit in which it was intended. It was not intended to be a learned discourse on opacity, or to indicate exactly how to arrive at finality in regard to photometric reflection. The purpose was to introduce the subjects which were to be pursued more fully in the future.

The vote of thanks was carried with acclamation.

MR. PEARCE, responding, said that the references to the U.S.A. were nothing more than an indication of progress that was being made there, and there was no suggestion at all in the Paper that American enamelling practice was either better or worse than ours. The point was to discover whether there was anything in the methods used in the States which might assist enamellers in this country and help them to retain the lead. Several speakers had put their fingers on the real point in stressing the influence of mass-production conditions in the United States. It seemed likely that such conditions would develop increasingly in this country, and in that case we might wish to make use of somewhat similar methods to those applied in America. In conclusion, he said that if suggestions such as that of Mr. Tait concerning his electrical instrument for measuring enamel thickness could be elaborated, they would be very valuable.

On the motion of Mr. A. England, a hearty vote of thanks was accorded to Mr. W. H. Whittle for his conduct of the meeting, and for the great work he had done for the Institute during the past year in his capacity as chairman of the Council.

The CHAIRMAN briefly responded.

In view of the attention which had been paid in the Paper and in the discussion to the problems of acid and alkali resistance in enamel, he asked whether the meeting felt that those subjects should be the first to be pursued by the Research Committee.

A number of members voted in favour of the suggestion that the Council should recommend the Research Committee to pursue the subjects of acid and alkali resistance first. There were no votes against that suggestion, and there were no further suggestions as to the order in which the problems should be pursued.

Problems for Copper Producers

BY "ONLOOKER."

Since the present control in copper was put into force there have been few who were disposed to cavil at the method of its operation or to suggest that the trade would be better off without it. Supplies have come forward quite freely, and there has never been any question of the market being tampered with or rigged in any fashion through the machinations of the controlling body. Those who remember the conditions ruling some years ago know just how deadly a stranglehold by a cartel of producers can be, for at that time the price was pegged at 18 cents, a ridiculously high level in view of the rate of consumption and the reserves of copper above ground. The London Metal Exchange went through a difficult time, but eventually the price ring was broken, and not unnaturally the aftermath brought a spell of very low prices while the excessive stocks were absorbed. That is fortunately a past incident, but the memory of it lingers still in a good many minds, and it is because of this rather unhappy recollection that the present arrangement is regarded with some misgiving in certain directions.

It is perhaps unfortunate that the cartel has found it necessary so quickly to abandon unrestricted production. It will be remembered that, about the middle of October, the market was rather taken aback to receive an intimation that output of those properties forming the copper cartel would be lifted forthwith to an unrestricted level. As an immediate result the London market, after a modest and short-lived rally, turned sharply downwards. Since then the tone has been very uncertain and price movements erratic, but it has been fairly obvious that confidence is badly shaken. Now the producers have gone back to restriction, and people are wondering whether this also will prove to be an erroneous move. In October it was generally understood that the decision to remove, albeit temporarily, all checks on production was reached because of fears that the market would develop the inflationary hysteria which sent it soaring upwards early in 1937. We find it hard to believe that the producers were so misinformed of the situation as to believe that this would occur, for the positions were not by any means parallel, and it is now generally recognised that although rearmament programmes may include heavy purchases of copper in order to create reserves in case of war, current consumption for munitions is not on the gigantic scale at one time visualised.

In their endeavour to regulate the flow of copper so as to hold a fair balance between supply and demand, the producers are up against a difficult proposition. Apart from the time lag between mine and refinery there is the problem of assessing prospective consumptive demand and deciding which way the trend will go. There is also the question of price, with the fear that a false step may precipitate either a buyers' strike or a situation which will encourage a big speculative bull movement. These possibilities have to be faced and a number of contingencies provided for, many of which are not apparent to the ordinary trader whose needs are satisfied by the purchase of relatively small tonnages.

What passes in the council chamber of the authorities in whom is vested the responsibility to decide policy is obviously not known, nor is any information available about the methods employed, apart from the raising and lowering of output quotas. In the early part of last year the affiliated producers are understood to have sold freely on the London standard market at one stage in a laudable attempt to check the ill-advised bull ramp, but whether this has been repeated, or whether indeed the standard market is used as a "governor," is not known.

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The Week's News in Brief

Trade Talk

EXTENSIONS to their foundry and machine shop are to be carried out by Burgess & McLaren, Limited, brassfounders, of Coatbridge.

THE NEW DESTRUCTOR COMPANY, LIMITED, Pershore, Worcs, have received a contract for a refuse destructor from Largs (Ayrshire) Town Council.

THE STANDARD BRASS, IRON & STEEL FOUNDRY COMPANY, LIMITED, of Benoni, S.A., have now moved into the new block of offices recently completed by them.

THE DEPARTMENT OF OVERSEAS TRADE announce that Mr. J. R. Adams, British Trade Commissioner at Brisbane, is now in the United Kingdom on an official visit. Mr. Adams will be at the Department of Overseas Trade for the week commencing December 5 for the purpose of interviewing manufacturers and merchants interested in the export of United Kingdom goods to Australia, after which he will undertake a short tour of certain industrial centres in the provinces.

THE NEW AIRCRAFT FACTORY at Trafford Park, Manchester, will be erected and controlled by the Metropolitan-Vickers Electrical Company, Limited, on behalf of the Air Ministry, and will be utilised as an assembly factory and for manufacturing some of the main components. The other main components will be manufactured by the following firms in the Manchester area: Crossley Bros., Limited; Crossley Motors, Limited; Dobson & Barlow, Limited; Donovan & Company, Limited; Ferguson Pailin, Limited; Hick, Hargreaves & Company, Limited, and Howard & Bullough, Limited.

CONSIDERABLE EXTENSIONS to their equipment for producing light alloy pressings have recently been completed at the Abberley Street Works, Birmingham, of James Booth & Company (1915), Limited. The plant is engaged principally in the production of aircraft propellers and pressings for large crankcases and similar equipment, and includes a 12,000-ton vertical forging press (believed to be the largest of its kind in the country for this class of work), a 1,200-ton press of the same type, and a 2,000-ton horizontal extrusion press. The motors and control gear were manufactured and supplied by The General Electric Company, Limited.

AN ISSUE of shares and ten-year notes is announced by the United Steel Companies, Limited. The directors, in announcing this issue, state that the object is to augment the financial resources of the company, "taking into account certain important negotiations which are now in progress." The share issue will comprise 882,180 shares of £1 each, and they will be issued to stockholders at par on the basis of one new share for every £10 nominal of stock now held. They will rank *pari passu* in all respects with the existing issued stock of the company. The company is also arranging to issue £1,500,000 of 4½ per cent. ten-year notes which will be placed privately.

THE FIRST REPORT of the Committee on High-Duty Irons for General Engineering Purposes of the Institution of Mechanical Engineers will be presented by the Reporter to the Committee, Mr. J. G. Pearce, at a general meeting of the Institution at Storey's Gate, St. James's Park, London, S.W.1, at 6 p.m. on Friday, December 16. Members of the Institute of British Foundrymen and others interested are cordially invited to be present at the meeting and to take part in the discussion. Those who propose to attend or who would like to contribute to the discussion in writing are invited to communicate with the Institution, and an advance copy of the report will be sent as soon as it is available.

WILLIAM JACKS & COMPANY inform us that, as and from January 1 next, their business will be converted into a private limited company. The change will make no alteration in the conduct of the business, the present three partners—Mr. J. Gray Buchanan, Mr. Stewart Barry and Mr. R. Russell Walker—continuing as chairman and managing directors to control its affairs, with the addition of the senior's son, Mr. William Gray Buchanan, and Mr. John C. Gammon, O.B.E., M.I.S.E. (who has for many years been associated with the firm in business in India and Malaya), as directors. The registered capital will be £250,000, and the issued capital £200,000. The business was established in 1880.

Personal

MR. RICHARD WISE, commercial manager of the Bowesfield Steel Company, Limited, Stockton-on-Tees, has retired.

MR. WILLIAM LOMAS, chairman of J. & J. Dyson, Limited, Griffs Firebrick Works, Stannington, Sheffield, celebrated his 96th birthday last Friday.

MR. F. NAYLOR, late manager of Broad & Company's foundry at Hanwell, Middlesex, has been appointed works director of the Renshaw Foundry, Limited, of Mill Mead, Staines, Middlesex.

MR. J. E. SPEAR has been appointed sales manager, Engineering Division, of British Timken, Limited, makers of roller and ball bearings. The position of railway representative to this company thus vacated by Mr. Spear has been filled by Mr. H. C. Tuffill.

MR. ROBERT RONCERAY, son of Mr. E. Ronceray, managing director of the firm of Ph. Bonvillain & E. Ronceray, of Choisy-le-Roi (Seine), has been appointed as from January 1, 1939, to the executive management of the company, of which he is already a director.

Will

WILKINSON, DANIEL, retired foundry manager, formerly of Lake & Elliot Limited, Braintree £16,999

Obituary

SIR ALFRED STEPHENS, managing director of Stephens Silica Brick Company, Limited, Kidwelly, died on Monday, aged 67.

MR. JAMES KERR, foreman ironmoulder at the Dalzell Works, Motherwell, of Colvilles, Limited, died last week at the age of 50.

MR. THOMAS URE, who was for over 40 years connected with Smith & Wellstood, Limited, ironfounders, of Bonnybridge, and was related to the Ure family, who originally founded the businesss under the name of George Ure & Company, has died, aged 81.

Company Reports

Birmid Industries, Limited.—Profit for the year ending October 31, £77,973; brought in, £14,340; dividend of 10 per cent., plus a bonus of 2½ per cent., £62,078; carried forward, £30,235.

Ley's Foundries & Engineering, Limited.—Consolidated trading profit and investment income for the year to September 30, £159,281; combined net profit for the year, after making estimated provision for taxes, £102,036; dividends paid by the subsidiaries and received by the parent company, £63,599; net profit of the parent company, £63,572; final dividend of 5 per cent. on the ordinary shares, making 11 per cent. for the year; carried forward, £15,918.

Stewarts and Lloyds of South Africa, Limited.—Trading profit for the year to June 30 last, £330,155; net profit after depreciation, £269,567; brought in, £53,693; to general reserve, £165,000; to contingencies reserve, £10,000; investments written down, £15,000; debenture redemption reserve, £4,871; to employees' fund, £10,000; dividend of 10 per cent.; carried forward, £62,389. To enable a 100 per cent. scrip bonus to be distributed the capital of the company is to be raised from £755,000 to £960,000. The directors will then capitalise £205,000 of the general reserve and allot to shareholders one new ordinary £1 share for each ordinary share already held.

Contracts Open

Esher, December 9.—1,476 yds. of 9 in. dia. and 142 yds. of 7 in. dia. cast-iron sewers; and 133 yds. of 4 in. dia. cast-iron rising main, for the Urban District Council. Mr. H. C. Fread, engineer, Council Offices, Esher. (Fee £3 3s., returnable.)

Gainsborough.—Supply and laying of 4,600 yds. of 3 in. dia. spun-iron water mains, specials, fittings, etc., for the Rural District Council. Mr. J. H. Haiste, consulting engineer, Middleton Chambers, Lowgate, Hull.

Catalogues Received

Fans. Catalogue No. V49, just issued by Keith Blackman, Limited, of 27, Farringdon Avenue, London, E.C.4, deals with the high-efficiency type of blowing and exhausting fans, and is of particular interest to our readers as the high and medium speed ranges (2,900 and 1,450 r.p.m.), are designed for blowing cupolas, oil- and gas-fired furnaces, gas producers, and the like. It is of their standard type of catalogue, and is in the main made up of tabular matter, which makes such brochures so valuable for reference purposes. It is available to our readers on writing to Farringdon Avenue.

High-Duty Castings. Though a sixteen-page brochure received from Modern Ironfoundries, Limited, of Halifax, deals in the main with the engineering potentialities of their high-duty castings, quite a large amount of space is devoted to "Modifier" refined pig-iron. In connection with this, photomicrographs are reproduced on buff paper, a practice to which exception can reasonably be taken as detracting from their value. The pamphlet is well illustrated by appropriate photographs, and the letterpress has been thoughtfully chosen and is nicely set out. It is available to our readers on writing to Halifax.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Strafford Iron Company, Limited.—Capital, £500. Subscriber: G. S. F. Barham, 13, Willoughby Road, London, N.W.3.

Bloore & Piller, Limited, 173, Hockley Street, Birmingham.—Capital, £25,000. Brass founders. Director: N. P. Piller.

Alright Products, Limited, Clifton Works, Ashfield Road, Burnley.—Capital, £5,000. Mechanical engineers, diecasters, ironfounders, etc. Permanent directors: G. W. Fletcher, J. W. Green, W. V. Green, W. J. Caldwell and G. Clayton.

Forthcoming Events

DECEMBER 5.

Royal Society of Arts:—"Refractory Materials," Third Cantor Lecture by Dr. J. H. Partridge, at John Street, Adelphi, London, W.C.2, at 8 p.m.

DECEMBER 7.

Manchester Metallurgical Society:—"Powder Metallurgy," Paper by Dr. W. D. Jones, at Assembly Room, Blackfriars House, Blackfriars Street, Manchester, at 7.15 p.m.

DECEMBER 9.

Manchester Association of Engineers:—Quarterly meeting. "Recent Developments in Aircraft Design," Paper by Dr. R. O. Boswall, at Engineers' Club, Manchester, at 7.15 p.m.

Institute of British Foundrymen

DECEMBER 7.

Lancashire Branch:—"Graphite Structure and Porosity," Paper by W. West and C. C. Hodgson, at Engineers' Club, Manchester, at 7.30 p.m.

London Branch:—Joint meeting with Institute of Metals. "Modern Non-Ferrous Foundry Practice," Paper by F. Hudson, at Charing Cross Hotel, London, at 8 p.m.

DECEMBER 10.

East Midlands Branch:—Paper on Machine Moulding, at College of Technology, Leicester, at 6 p.m.

Scottish Branch:—"Production of Certain Iron Castings," Paper by J. Roxburgh, at Royal Technical College, Glasgow, at 4 p.m. Annual dinner at Grosvenor Restaurant, at 6 p.m.

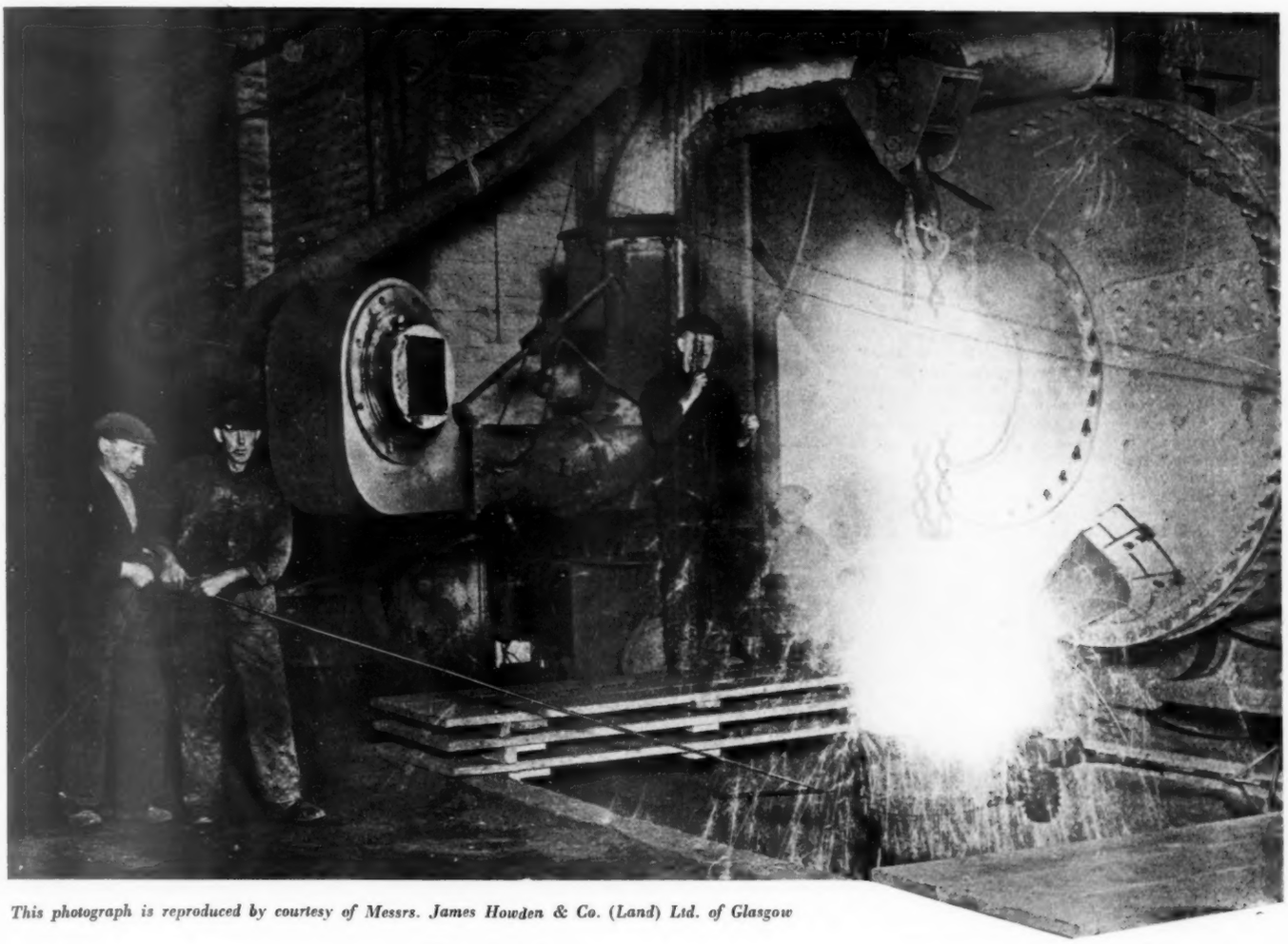
Wales and Monmouth Branch:—Joint meeting with Newport Metallurgical Association. "Ingot Moulds and Steel Rolls," Paper by Dr. A. B. Everest, at Newport Technical College, at 6 p.m.

West Riding of Yorkshire Branch:—Report of Cast Iron Sub-Committee, presented by G. L. Harbach, at Technical College, Bradford, at 6.30 p.m.

The Institute of Vitreous Enamellers

DECEMBER 8.

Midland Section:—"Scientific Aids to Control in Vitreous Enamelling," by Dr. G. T. O. Martin, at Chamber of Commerce, New Street, Birmingham, at 7.30 p.m.



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Raw Material Markets

The iron trade is hopeful of an early decision with regard to the new price schedules. The amount of new business now being placed certainly does not reflect the true position of trade, and when forward quotations are made known, it is expected that there will be a considerable amount of buying. Meanwhile, pig-iron stocks at the producers' end are being cleared at a good rate and an expansion of output is likely in the near future.

Pig-Iron

MIDDLESBROUGH.—Apart from a few small transactions for prompt delivery, there continues to be no new business in this district. Makers' stocks are steadily being drawn upon to meet existing contracts, but producers are reluctant to relight blast furnaces until they can feel the pulse of future trade. It is, however, anticipated that consumers will have fairly substantial orders to place in the New Year and makers are likely to be compelled to increase their outputs, which at present are very small. For delivery in this district up to the end of the year, prices of Cleveland iron are nominal at 109s. for No. 3 G.M.B., 111s. 6d. for No. 1 and 108s. for No. 4 foundry iron and No. 4 forge, less 5s. rebate.

Although hematite users are becoming busier and are taking up contract deliveries on a freer scale, producers are in a better position than are makers of foundry iron, as most consumers are so heavily in arrears with their contracts that it will be a considerable time before they place new orders, whatever the trend of future prices. Thus, the need for an expansion of output is not likely to arise just yet.

LANCASHIRE.—Reorganisation of armaments production is expected to result in an increase of orders among textile machinists in this area, the majority of whom are not well placed for work at present. Light-castings makers, also, are working short time, but there has been an improvement in jobbing founders' order-books, although this section is by no means satisfactory. Most other consumers of foundry iron have practically cleared their stocks of iron, although they are not entering into new business unless they are forced to, and even then only small tonnages are changing hands. Hematite is rather better, but consumers are much in arrear with contracts.

MIDLANDS.—The iron market in this area remains unchanged, owing to the obscure outlook. It is certain that new business will be released when forward prices are announced, but many consumers are still covered ahead and are not taking up supplies so well as might be desired, although there has recently been an improvement. On the other hand, low-phosphorus iron is moving away freely under the impetus of the armament programme. The price of this iron varies from £5 10s. to £6 10s., delivered in the Midlands. The fixing of hematite prices is unlikely to change the market outlook very appreciably, as most users are already committed for heavier tonnages than they will require before the end of the year.

SCOTLAND.—From the amount of hand-to-mouth business that is going through it is obvious that many consumers are in the position to enter into forward contracts and will do so when the opportunity is afforded them by the announcement of future quotations. No. 1 foundry iron is currently quoted at 120s. 6d., and No. 3 118s., f.o.t. furnaces. Steelworks, being well covered for supplies, are not very prominent in the market. Quotations for steel-making irons are unchanged at 133s. for hematite mixed numbers, 107s. 6d. for Scottish basic, and 100s. for English and Indian basic, all delivered f.o.t. steelworks and less 5s. rebate.

Coke

Foundry coke continues to be well taken up and home and export business is satisfactory. For delivery to Birmingham and Black Country stations, best Durham coke is quoted at 50s. 6d., with Welsh coke at from this figure upwards.

Steel

Most sections of the steel market have developed a certain amount of activity, although the current business consists largely of consumers' purchases of supplementary parcels to carry them on until the end of the year. Although most of the steelworks are operating at considerably below capacity, outputs appear to have improved of late and the tone of the market has become stronger. An expansion in the volume of business early in the New Year is generally anticipated, and for this reason the announcement of the new prices which will rule is awaited with some impatience. Business in semi-finished steel seems to be gradually expanding. The rigid control of imports and the reduction in consumers' stocks have resulted in a better flow of orders to the British works, and this section of the industry has more business in hand than for some time past. Business in finished steel has expanded somewhat of late, but it is still spread irregularly over the market. The demand is limited to small parcels, but amounts in the aggregate to a respectable tonnage. Buying on export account is restricted, but there is a fair volume of inquiry in the market.

Scrap

There has been a further increase in the demand for heavy steel scrap and business in this section is definitely improving after having passed through a very quiet period. Many consumers who had suspended contract deliveries are now calling for these quite satisfactorily. Nevertheless, steel scrap is not so active as it should be and there is room for a much-increased consumption. Other sections of the market are satisfactory.

Metals

Quotations for non-ferrous metals declined sharply on Monday as a result of the setback on Wall Street over the week-end and the disturbed situation in France. On the whole, business has been quiet during the past week.

Copper.—The announcement last week that copper producers operating the restriction scheme had decided to reimpose the control on the production of the metal did not cause very much surprise. Production will be reduced by January 1 next to 110 per cent. of basic quotas. Consumers are showing little interest in new business, and are only covering their immediate requirements. Home industrial demands are disappointing, but are aided by the requirements of firms engaged on the manufacture of armaments. The U.S.S.R. and Japan have continued to take up fairly substantial tonnages. Business in France has been upset by the widespread strikes, which have affected the metallurgical industry. In the United States, the price of copper scrap fell ⅛ cent per lb. on Monday to 8⅜ cents, which is equivalent to 10¼ cents for refined copper. Although the domestic quotation remains unchanged, it is thought likely that a reduction will be made should the price of scrap weaken further.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £45 5s. to £45 6s. 3d.; Friday, £45 1s. 3d. to £45 3s. 9d.; Monday, £43 11s. 3d. to £43 13s. 9d.; Tuesday, £43 8s. 9d. to £43 10s.; Wednesday, £43 13s. 9d. to £43 15s.

Three Months.—Thursday, £45 8s. 9d. to £45 10s.; Friday, £45 5s. to £45 6s. 3d.; Monday, £43 16s. 3d. to £43 17s. 6d. Tuesday, £43 12s. 6d. to £43 13s. 9d.; Wednesday, £43 18s. 9d. to £44.

Tin.—The International Tin Committee's decision to maintain existing quotas over the first quarter of next year was favourably received in tin circles and the tone of the market improved. Business has expanded and buyers have been more inclined to cover their forward requirements. Nevertheless, the outlook is not too clear, as the market is still dominated to a large extent by the international situation, and the market is unlikely to settle down until a more pacific policy is pursued among European States.

The November issue of the Statistical Bulletin published by the International Tin Research and Development Council states that world tin production in 1938 shows a considerable decline. In 1937 there was an average quarterly production of 52,100 tons, whereas in the first quarter of 1938 production fell to 43,100 tons, in the second quarter to 39,200 tons and in the third quarter to 32,300 tons. World production in September, 1938, amounted to 10,200 tons, against 19,400 tons in September, 1937. Apparent tin consumption shows the same trend. The quarterly average for 1937 was 49,700 tons; in the first quarter of 1938 consumption declined to 41,000 tons, in the second quarter to 40,000 tons and in the third quarter to 34,300 tons. World apparent consumption in September amounted to 13,000 tons, against 18,400 tons in the corresponding month of last year. World tinplate production in the third quarter of 1938 amounted to 688,000 tons, against 730,000 tons in the second quarter and 743,000 tons in the first quarter. The quarterly average for 1937 was 1,064,000 tons.

Official quotations were as follow :—

Cash.—Thursday, £215 15s. to £216; Friday, £216 to £216 2s. 6d.; Monday, £214 10s. to £214 15s.; Tuesday, £214 10s. to £214 15s.; Wednesday, £215 5s. to £215 10s.

Three Months.—Thursday, £216 12s. 6d. to £216 15s.; Friday, £217 to £217 5s.; Monday, £215 5s. to £215 10s.; Tuesday, £215 5s. to £215 10s.; Wednesday, £216 2s. 6d. to £216 5s.

Spelter.—There is little improvement to report in the condition of this market, and business continues to be confined to small transactions. The tone of the market was further weakened by reports that negotiations in connection with a revival of the International Zinc Cartel were not progressing very favourably.

Daily market prices :—

Ordinary.—Thursday, £14 6s. 3d.; Friday, £14 2s. 6d.; Monday, £13 15s.; Tuesday, £13 13s. 9d.; Wednesday, £13 18s. 9d.

Lead.—A steady tone has prevailed in this market, and business in this country has been on a moderately good scale. Continental and Japanese consumers have bought fairly substantially of late. The market is not yet feeling the effects of the control scheme and meantime is likely to move in sympathy with other metals.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £16 6s. 3d.; Friday, £16 6s. 3d.; Monday, £15 16s. 3d.; Tuesday, £16; Wednesday, £15 18s. 9d.

Scrap.—Business in this country has been rather quiet, while exports have tended to decline. The rearmament programme is an important factor in the consumption of new metals, but there is very little demand from this source for scrap.

Approximate selling prices for old metal:—New aluminium cuttings, £70; rolled, £53; cast, £30; foil, £80. Copper, £39 10s. to £44; braziery, £35 10s. Brass (clean), £21 to £23. Zinc, £11. Lead, £15 5s. Gunmetal, £41.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal" :—

"STARCAST."—Grey iron and non-ferrous castings. Star Foundry Company, Limited, Bradley, Bilston.

"ISOLAFETY."—Steam valves. Royles, Limited, Dalham Engineering Works, Liverpool Road, Irlam, Manchester.

"LARNER-JOHNSON."—Valves. J. Blakeborough & Sons, Limited, Woodhouse Works, River Street, Brighouse, Yorks.

Engineering Wages

The employers' reply to the wages and other claims presented by the engineering unions will be given at a conference in London on December 6 between the Engineering and Allied Employers' National Federation and the Amalgamated Engineering Union and the National Union of Foundry Workers. A separate meeting between the Federation and the Confederation of Engineering and Shipbuilding Unions will follow. The claims of the Confederation are: Increase in rates of time workers and equivalent advances to men on systems of payment by results; a shorter working week; the restoration of the rates and conditions which operated prior to June, 1931, as affecting piece work, overtime, night shift and shift working; and holidays with pay. A substantial increase in wages, the restoration of pre-June, 1931, working conditions, and the consolidation of war bonus into wage rates, are the demands of the A.E.U.